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SOLID WASTE DISPOSAL PROGRAM
for
METROPOLITAN BOSTON

VOLUME I

prepared by the
METROPOLITAN AREA PLANNING COUNCIL

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March, 1967

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PART I

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Commonwealth of Massachusetts
METROPOLITAN AREA PLANNING COUNCIL

in cooperation with

Metropolitan District Commission
Massachusetts Department of Public Health

and with the

Urban Renewal Administration
U.S. Department of Housing and Urban Development

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SOLID WASTE DISPOSAL PROGRAM
for
METROPOLITAN BOSTON

VOLUME I

first of three volumes

REVIEW DRAFT

INTRODUCTION

The victims of our affluent society - the old refrigerator, the family stove, the vintage automobile, the morning newspaper, and a wide variety of other items -- are being discarded at an ever-increasing rate. These rapidly growing piles of waste have created an air of national crisis--a crisis which prompted the 89th Congress to pass a national Solid Waste Disposal Act in 1965.*

Metropolitan areas from Maine to Florida and from New York to California are faced with an avalanche of solid waste which is approaching 165 million tons per year and which by 1980 will surpass a yearly total of 260 million tons. The Boston Metropolitan area, like all other metropolitan areas, is no exception. Existing solid waste disposal systems are both inadequate and unacceptable--even for present area waste volumes. As these volumes of waste are increasing, vacant land space available for disposal purposes is rapidly decreasing. Also, there are new and increasing demands for land for recreation and open space, housing, industry and industrial parks, shopping centers, transportation and the like. Finally, open dumps continue to operate at a time

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* Public Law 89-272.

when individuals, organizations and all levels of government are demanding more stringent air and water pollution controls which require a concerted coordinated effort.

For all of these reasons, this action-oriented metropolitan solid waste disposal program is proposed. The program was prepared by the Metropolitan Area Planning Council in cooperation with the Massachusetts Department of Public Health and the Metropolitan District Commission. The MAPC was created by Chapter 668, Acts of 1963 and has been designated as the official planning agency for the 79 communities in the Boston metropolitan area.* The agency is designed to study metropolitan problems and to prepare plans and programs for improvement of conditions with respect to optimum land use and efficient provision of utilities and facilities. The program was financed in part by appropriations of the General Court of assessments of not more than five cents per capita for member com-

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* Legislation in 1964 defined the Council as being the 78 communities in the 1964 census definition of the Boston SMSA plus the Town of Stoughton. Since this study was begun, amendments have increased membership to 83 communities.

munities, and partially by a grant from the Federal Department of Housing and Urban Development.

Data was collected and assimilated by an environmental health team of resident, full time staff of the MAPC. vital assistance was also provided by staff members of the MDPH, the MDC, special Technical Committees of the Council and several private consulting firms.

This report is the culmination of that study and it is intended to cover the following subject matters:

1. A recommended program of action, the program based on:
2. An inventory and evaluation of the types and amounts of solid wastes to be disposed in the next 25 years in the Metropolitan Area.
3. An analysis of the technical means for disposal of solid wastes, present and potential.
4. An analysis of the administrative and financial means--both available and required.

The following pages will discuss in detail the plan and program and its relationship to needs in the metropolitan area. The proposals which make up the plan and program include specific indications as to the size and type of central facilities to be developed, and target dates for their construction or operation. In addition, the plan and program make specific recommendations as to the administrative and financial means for carrying it out.

SUMMARY OF RECOMMENDATIONS AND FINDINGS

Summary of Recommendations

1. The solid waste disposal program recommends a system of regional incinerators and sanitary landfills designed to serve the communities of the Boston Metropolitan Area.

2. The Metropolitan District Commission should be designated as the agency to carry out the recommended solid waste disposal program. Legislation is needed this year to empower the MDC to construct the needed regional facilities and administer the regional disposal system.

3. An MDC Advisory Board for Solid Waste Disposal should be created made up of the chief executive officers of the participating cities and towns. The Advisory Board should have the authority to approve or disapprove the solid waste disposal development program including the expenditure of funds.

4. The program recommends the construction of nine regional incinerators and eight sanitary landfill operations in order to dispose of all domestic, commercial, and industrial solid waste generated in the Metropolitan Area through 1990.

5. The nine incinerators should have a total capacity of 10,900 ton per day by 1990. Nearly half of this capacity will be required by 1971.

6. Five incinerators are needed now and should be given the highest priority. These incinerators should be constructed in the areas immediately north, northwest, southwest, and southeast of Boston and major renovation of the South Bay incinerator in Boston is needed.

7. The total capital improvements program recommends an expenditure of $84,000,000 to be raised by general obligation bonds. A $59,000,000 bond issue should be authorized in 1967; an additional $15,000,000 bond issue will be needed by 1973; a third $10,000,000 bond issue will be needed by 1984. These figures do not include funds for the acquisition of existing facilities, which communities might want to sell to the MDC.

8. The total expenditure required for incinerator construction through 1990 is estimated at $47,600,000 at current prices. This estimate assumes a high level of design utilizing modern technological devices to meet the most stringent air pollution standards.

9. The annual cost for solid waste disposal in the entire metropolitan area, including both the communities using new regional facilities and communities using existing local facilities, is estimated at $26,000,000 in 1970. This cost includes $7,300,000 for operation of disposal facilities, $5,000,000 for debt service and $13,500,000 for refuse collection.

10. Charges for capital and operating costs should be shared by member communities on the basis of actual tonnage delivered to a regional facility.

11. Commercial and industrial firms should be charged on a per ton rate that is sufficient to offset the operating and increased capital costs that occur because of increased capacity requirements to provide commercial service.

12. Advanced land acquisition of all incinerator and sanitary landfill sites is recommended. This acquisition should be carried out following engineering evaluation of all possible sites.

13. Regional sanitary landfill operations should be initiated as soon as practical and in accordance with the schedule to be adopted by the communities in the solid waste disposal system.

14. Open dumps should be prohibited in urban and suburban areas throughout the Commonwealth in the interests of public health and in compliance with Federal requirements for solid waste disposal aid. The Department of Public Health should adopt regulations that require the conversion of existing open dumps to sanitary landfills in accordance with a precise time schedule.

15. Collection of solid waste from the household and delivery to the regional facility should be the responsibility of each local community. Local procedures should require combined collection of rubbish and garbage, and wherever possible, at curbside. For health and economic reasons collection should take place at least once weekly in Winter and twice weekly during the Summer.

16. The MDC should establish the kinds of materials to be accepted at regional facilities and the timing of local deliveries to the facilities.

17. Apartment house and all other small incinerators should be banned or improved to meet air pollution control standards to be developed and adopted by the Department of Public Health.

18. The use of garbage grinders should be encouraged, where sanitary sewer systems permit and where existing sewage treatment plants have sufficient capacity. Garbage grinders should be encouraged on a total neighborhood basis in order to eliminate the need for weekly or twice weekly garbage collections for a few households.

19. It is anticipated that the recently constructed shredding plant in Everett will have sufficient capacity to handle junk automobiles, refrigerators, stoves, and other appliances for the next 25 years. Remaining junkyards, automobile graveyards, and wrecking operations should be controlled by landscaping, screening and other protective provisions in local community ordinances.

20. The metropolitan area should continually seek all possible Federal aid pertaining to solid waste disposal. In particular, funds for personnel training and funds for demonstrations in solid waste management and new methods of disposal should be applied for and used. Under the latter program continued research in solid waste technology, such as high temperature incineration, should be conducted.

21. The solid waste disposal program should include the construction of selected facilities to demonstrate and evaluate new techniques of waste disposal for use throughout the metropolitan area.

22. A Statewide assistance program is needed to stimulate high quality service throughout the Commonwealth. This program should provide grants to regional disposal agencies for a portion of the capital costs of solid waste facilities, including incinerators, sanitary landfills, and other approved disposal methods.

Summary of Findings.

1. During 1965, the metropolitan area produced a waste volume of: 1,278,000 tons of residential refuse; 67,000 tons of bulky items; 870,000 tons of non-residential wastes; 400,000 tons of demolition materials; and 80,000 junked autos. Agricultural and fishery wastes do not constitute a problem at this time.

2. The yearly per capita generation rate of refuse was found to be 1,000 pounds per year, and per capita annual growth rate of refuse was found to be 2 per cent.

3. The total refuse produced shows a range of 60-80% for combustibles and 20-40% for non-combustibles (by weight). Domestic refuse composition in the metropolitan area was found to be 85% combustible and 15% non-combustible. Variations from these figures are attributed to size of the community, and to the type and predominance of industry therein.

4. Each person in our metropolitan area generates enough household waste to utilize 1.7 cubic yards of sanitary landfill (at 600 pounds per cu. yd.) per year. If however, all solid wastes (bulky items, non-residential wastes, demolition materials, etc.) are included, this required area rises to 3.1 cu. yds. per capita per year.

5. As industrial and commercial uses of plastics, cellophanes and other related materials increases, this use is reflected proportionately in the composition of household refuse.

6. Garbage grinders are rapidly increasing in use--particularly in new home construction--and are encouraged where the sanitary sewerage system permits. Such use decreases the amount of garbage which must be collected.

7. By 1990, the metropolitan area will be producing 2,613,000 tons of residential waste; 137,000 tons of bulky items; 1,147,000 tons of non-residential refuse; 740,000 tons of demolition materials; and 165,000 junked autos per year.

8. Of the 79 communities in the metropolitan area, 76 are served at least partially by open dumps, 3 are served by sanitary landfills. Of these, 15 are served also by incinerators; and 15 have no facilities whatever and are served by a single commercial dump.

9. Current nuisances observed at open dumps include rodent infestation, heavy smoke, blowing papers, dust, and pollution of nearby streams and recreation areas. In many instances, supposed sanitary landfills were found to be operating as open dumps. Incinerators will not meet the more rigid air pollution codes that are anticipated in the near future. Some incinerators can burn far less than their rated capacities.

10. Open burning is prohibited in the 30 community Metropolitan Air Pollution Control District. At many sites visited, at least partial burning was found.

11. By 1970, most of the existing open dumps and landfill facilities will be exhausted.

12. In the recommended system of incineration and sanitary landfilling, 73,000 acre feet of land volume is needed for the solid wastes and incinerator residues to be disposed of over the next 25 years.

13. The Massachusetts Department of Public Health recognizes incineration, landfilling, and composting as acceptable methods of disposal; discourages uncontrolled open dumping.

14. Per ton disposal costs vary according to the size of the facility but, generally, costs range from $1.80 to $5.72 per ton for landfills and from $3.42 to $12.13 for incineration. The cost of compost plants compare with incinerator costs. The cost is lowest in large regional facilities.

15. Many communities are presently exploring disposal by incineration and some have expressed an interest in inter-community agreements.

16. State legislation has existed since 1965 which allows communities to form regional waste disposal districts. To date, no such districts have been established in Massachusetts.

17. Collection of solid wastes normally handled by a municipality will account for approximately 70-75 per cent of its total cost.

18. In some instances, contract collection is cheaper than municipal collections. A combined collection once weekly from curbside was found to be the least expensive and most acceptable method of collection. Collection should be carried out twice a week during the summer.

19. Throughout the area, there is a wide variety of collection systems. Nine communities have no organized collection, 19 communities collect garbage, but make no provision for rubbish collection, and 51 communities employ both rubbish and garbage collection.

20. In 67 communities, garbage is taken to piggeries, while in only 6 is garbage combined with rubbish in the final disposal. This combination system is not only in areas using incinerators or sanitary landfills but was also found in areas using open dumps.

21. Frequency of collection is also varied. Garbage is collected from 1 to 3 times per week while rubbish is collected as infrequently as once a month and as often as 3 times per week (in some parts of Boston).

22. Packer trucks of 16, 20, and 25 cu. yds., are used for collection services. These trucks compact the rubbish from a density of about 250 pounds per cu. yd. as received, to about 550 per cu. yd. in the truck. Garbage is usually removed from underground receptacles in back yards and hauled in trucks of 12 cu. yds. capacity. Open trucks are most often used for bulky item collections.

Summary of Disposal Methods

There are several disposal methods which could be utilized in the metropolitan area. They range from open dumping to incineration, as discussed below:

Open Dumping is the uncontrolled disposal of solid wastes in an area where no cover material or organized operation is provided. Because they appear to be the least expensive method of disposal, open dumps have been popular in the past. Most authorities consider open dumping to be an unsatisfactory means of disposal, because they result in health and nuisance conditions.

Piggeries are places which use garbage as feed for swine. Few municipalities within the metropolitan area now have such facilities. Because of health considerations, the garbage must be cooked before its use as feed and since only edible wastes can be disposed of, additional disposal methods are required.

On-Site Incineration is the disposal by small incinerators in apartment buildings, stores, or industrial plants and which reduce the volume of the refuse at its source by burning. Unless a far greater degree of air pollution control can be attained, these facilities cannot be recommended.

Composting is disposal by the controlled decomposition of wastes. Refuse is subjected to rigidly controlled temperature, moisture, and variables of nitrogen and oxygen. Costs are similar to incineration, but reduction is considerably less. A more favorable market for compost material is necessary before this method could be a significant part of a metropolitan system.

Sanitary Landfilling is the process of controlled depositing of solid wastes in land areas. Wastes are dumped into a prepared trench or depression, compacted, in cells, and covered with 6" of compacted soil each day and finally covered with 2' of compacted soil. This is an approved method of waste disposal and is recommended in this plan, where there is adequate land available. Landfills eliminate nuisances which are associated with dumping operations.

Incineration is the controlled reduction of wastes by enclosed combustion, which reduces burnable refuse to ash by high-temperature burning. It is both efficient an effective means of disposal in urban areas where space requirements are important. This is an approved method of solid waste disposal when the facilities are properly designed and operated. Air pollution control equipment is required and new continuous feed operations are recommended.

Garbage grinders are small home mechanical devices which grind garbage before it is flushed into the sewer system. They are an approved method for the disposal of garbage.

Shredding. By this method, bulky objects such as junk automobiles, refrigerators and stoves are reduced to small fist-size particles. The new plant in the City of Everett has sufficient capacity to take all such bulky items generated in the next 25 years in themetropolitan area.

CHAPTER I

SOLID WASTE DISPOSAL PROGRAM: OBJECTIVES AND ALTERNATIVES

OBJECTIVES

The objectives of this waste disposal study are:

1. To plan a technically competent and efficient solid waste disposal system.
2. To plan a regional system which can be adapted to changing needs over time, and
3. To propose a waste disposal program that delineates the process of converting the plan into financing, administration and operation of solid waste disposal facilities.

Technical Competence and Efficiency

This objective requires a waste disposal system which will enable the metropolitan area of Boston to benefit from technological developments in the solid waste disposal field. Some of the technical competence and research ability which helped to create new and improved products for economic utilization has finally been directed toward the development of new and improved methods of disposing of the discards. It is generally agreed that the open dump is no longer an adequate solution to the disposal problems in many of the metropolitan area communities. There is a need for a consideration of other, new and improved methods of waste disposal. The best plan must consider the

latest thinking on this matter and apply as much of it to a proposed solution as is possible. In addition, the plan should be designed to represent the highest level of service possible at the lowest possible cost.

Flexibility

Systems are rarely fixed or static and many components of various systems do change over time. A realistic solid waste disposal program must be designed so that it is adaptable and flexible enough to accommodate new situations and new demands with the least amount of difficulty. (i.e. dumps can be converted into sanitary landfills and sanitary landfill sites can be converted into incinerator sites. Incinerator sites may be interchangeable as transfer stations or as compost plants.) In addition, facilities should be designed so that they can be enlarged. New methods of disposal can also be phased in and old methods can be phased out, as technology and experience dictate.

Proposed Implementation

The technical proposals of the plan must be easily implemented. Legislative recommendations and guidelines for action are important, and the plan must be practical in its suggested alternatives as to district formation, sites' selection and acquisition, financing and general administration.

Finally, and most important, all elements of the Solid Waste Disposal Program must be wisely related to the many other metropolitan development policies and programs (i. e., open space and recreation needs, economic and industrial considerations as well as transportation).

A Regional Waste Disposal System

The recommended regional system of incinerators and sanitary landfills is the only one which will adequately satisfies the stated objectives for the following reasons:

1. Vacant Land Distribution. An inventory of current disposal facilities has shown that most existing land disposal areas will be filled by 1970. A survey of vacant land areas, which may be available for future disposal, indicates that almost all such areas are located outside of Route 128 -- thus necessitating long-distance hauling by communities located within Route 128. Twenty-six out of twenty-eight inner communities and several outer communities have a land scarcity. Thus, the distribution and location of vacant land requires inter-community action.

2. Minimum Standards. Throughout the various phases of this report, basic minimum standards are recommended for waste collection and disposal operations. One of the most important recommendations emphatically states that all open dumping

of sanitary landfills and incinerators should be prepared, promulgated and adopted by the Department of Public Health, and all disposal facilities should conform to these standards within six months of their adoption. The implications of these recommendations are far reaching for, of the 79 communities in the metropolitan area, 76 are served at least partially by open dumps.

The problem, however, goes further, because the limited capacity of existing landfills and the age and obsolescence of existing incinerators will necessitate the construction of new disposal facilities. If such facilities are constructed and operated by the individual communities, it is anticipated that as many as 38 communities will be faced with the building of new incinerators by 1990. Under the recommended plan, nine regional incinerators will be required by 1990. Acting independently only a few communities could offer individual disposal at less than $5.00 per ton, and only the city of Boston could match the $3.30 per ton figure that is expected in regional facilities. In addition, several of the 38 communities could not even sustain a minimum sized, continuous feed modern plant of 240 tons per day. About 20 communities would be operating the minimum sized 240 ton per day plant, which at lowest cost (burning capacity) would be $7.34 per

ton. Since most of the small plants would be operating well below this capacity, the cost would average $8.00 or $9.00 per ton. If individual landfills were operated instead of incinerators, it was found that seven metropolitan area communities could not support a minimum sized 30 ton per day landfill. The cost of this operation is estimated to be $6.59 per ton. For the 32 communities whose loadings would be in the 30-100 ton per day range, a high per ton cost of $3.44 to $6.59 would still exist. Thus, not only will a regional solution provide the vacant land quantities needed for adequate disposal, but it can also distribute and combine refuse volumes for disposal at the lowest possible cost per ton.

3. Optimum Size. Given the need to maintain a suitable and efficient level of service, it was found that as tonnages handled at a disposal facility increase, the cost per ton disposed decreases. When approximately 500 tons per day at a landfill or 1200 tons per day at an incinerator is reached, the costs tend to level off and no further substantial economies are realized. If, for example, incinerators are operating at capacity with no provision for diversion of wastes to other incinerators in case of breakdown or shutdowns for maintenance and repairs, a 100 ton per day

facility shows a per ton cost of $7.34; a 600 ton facility shows a cost of $5.15 per ton; and a 1200 ton facility shows a cost of $3.30 per ton, and an 1800 ton facility shows a cost of $3.25 per ton. Similarly, a 30 ton per day landfill (without cover available at the site) shows a cost of $6.59 per ton; a 500 ton operation a cost of $2.48, and a 1000 ton operation a cost of $2.35.

a. Manpower and Equipment. A major part of this cost-saving is a result of savings in manpower. In comparing the cost differences between two 600 ton per day incinerators, and a single 1200 ton per day unit, it was found that each 600 ton facility (operating on one shift) would require an operating staff of 16 men -- or a total of 32 men for two facilities. If, however, the single 1200 ton per day incinerator is built, the labor requirement for one shift would drop to 26 men. Thus, by building the one, larger facility, a saving of 6 men or approximately $30,000 per year could be realized. Manpower and cost savings are proportionately similar for 2 and 3 shift operations.

Savings in labor costs are also realized in the large, regional sanitary landfill. For example, a comparison is made between five 100 ton per day landfills, and one 500 ton per day landfill. The 5 small facilities would require

a total of 10 men at a cost of $75,000 per year. In the larger 500 ton operation, however, only 5 men at a cost of $40,000 per year would be needed.

Comparison of landfill equipment cost also indicates a saving for the larger landfill. If, for example, 5-100 ton per day landfills were operated, 5 bulldozers (compactors) would be required for a total cost of $50,000 per year. At a 500 ton per day operation, only two bulldozers, at a cost of $20,000 would be required.

Thus, both labor and equipment costs indicated a substantial saving in large regional facilities.

b. Cover Material. Still another area where savings are realized, if a regional facility is operated, is found in sanitary landfill cover material. A 30 ton per day landfill, for example, was found to require almost twice as much cover material as a 500 ton per day operation. Statistics show that 1.57 cu. yds. of cover material are needed each day at a 30 ton per day landfill; 1.00 cu. yds. at a 100 ton per day operation; .88 at a 200 ton; and .81 at a 500 ton. It was also found that cover requirements remained constant at any landfill over 500 tons per day. Since the approximate cost of 1 cu. yd. of cover material (delivered to the site) is $1.50, the larger regional facility will again result in substantial dollar savings.

4. Management. A regional program of solid waste disposal has many administrative benefits. Location of management control in a headquarters office in a central location creates several economies. This arrangement allows and encourages central purchasing and planning, as well as accounting and budgeting procedures. With central fiscal control, financing and assessing of charges become more reliable and accurate. The regional administrative authority can allow itself a degree of adaptability and flexibility, and the highest levels of administrative and technical skills are shared by even the smallest communities. With financial and informational control, technical personnel and equipment can be shifted from one facility to another to meet and relieve shortages when and where they occur. Regionalism thus allows even the smallest community to benefit from a high level of technical competence.

Central location and organization (for example, in Boston) increase the agency's ability to communicate and cooperate directly with other related agencies. A solid waste disposal program will require a degree of cooperation with both state and local departments of health, public works, fire, police, and conservation. These as well as other administrative economies, in travel time, office space rentals and personnel

management will result from a well-planned and organized regional solid waste disposal program.

5. Legislative Direction. Several laws recently passed by the federal government have emphasized a regional comprehensive approach to urban problems. For example, loans will not be given for mass transportation facilities unless a comprehensive program has or is being developed for the entire urban area. This same attitude is reflected in the 1961 Federal Housing Act; the Highway Act of 1962; Air, Water and Sewer Facilities, and Water Pollution Acts, and the Demonstration Cities and Metropolitan Development Act of 1966. Many federal administrators advocate that all federal grant programs which affect the environment should be linked to metropolitan planning in the forseeable future.

This type of planning and organization is also reflected in state administrative actions. Various sessions of the state legislature have amended the General Laws to allow the formation of regional health, school, welfare, and vocational school districts. The Metropolitan District Commission was created to perform a number of municipal services and the Metropolitan Air Pollution Control District was established in 1961.

Thus, the emphasis now being placed on comprehensive regional planning indicates that funds will be more readily available for areas which show a willingness to participate in regional solutions.

Comparative Costs of Four Alternative Systems

Four alternative systems of solid waste disposal were evaluated:

1. Community incineration and sanitary landfilling with each municipality operating its own facility.

2. Regional sanitary landfilling provided for all municipalities in the region.

3. Regional incineration provided for all municipalities in the region.

4. Regional incineration and sanitary landfilling provided in accordance with municipal demand and location.

In this evaluation, two basic cost factors were compared -- the cost of hauling refuse and the capital and operating costs of the disposal facilities. The recommended system, which combines regional incinerators and regional landfills, yields the lowest cost among the four systems.

Before discussing each system in detail, the transportation of refuse requires further discussion. Transportation involves local collection, which is the travel time in the community for local pick-up and hauling, which is the travel time from the last pick-up to the disposal facility and back. In the case of incineration, there is often a second haul in

transporting the residue to the final disposal site. The cost of local collection for all systems would be the same and, therefore, is not shown in the comparison.

The haul costs are higher in the regional systems than in the community system. Therefore, the haul cost is computed in the comparison. Regional facilities are 1/4 to 1/2 the total cost of small local facilities. This savings more than offset the increased haul cost in the recommended regional system.

The alternative system all assume the same hauling vehicle, a 25 cubic yard compactor truck averaging six tons per load and costing $18.00 per hour for operating, maintenance, and depreciation. The use of large transfer vehicles to transport waste from several compactors to the disposal facility was also tested. The transfer vehicle is assumed to be a 40 cubic yard trailer truck capable of carrying 12 tons of compacted refuse or 24 tons of incinerator residue and costing $8.00 per hour.

Community Incineration and Landfilling

The arrangement whereby each community provides its own incinerator or sanitary landfill is similar to prevailing conditions in the region. The perpetuation of this method would require the construction of 38 new incinerators by

1990. This number of incinerators will be needed to replace existing incinerators as their usefulness is exhausted and to conserve community landfills. The haul cost to the local incinerators will average $1.25 per ton. Most of the incinerators will be small, 240 tons per day or less, and their operating cost will average $8 to $9 per ton. Much of their capacity will remain idle over the useful life of the plant, since they would be designed to accommodate tonnages which will not materialize until the very end of the 25-year period. Residue hauling and final disposal at the sanitary landfill will equal $1 per ton. A Cost Summary is as follows: This summary omits local landfilling which will average $5.00 per ton for disposal and $2.00 per ton for haul.

Haul to Incinerator	$1.25
Cost of Incineration	8.00
Haul and Final Disposal	1.00
	$10.25

Regional Landfilling

A system of regional landfills for all communities would be located outside Route 128, where land is available. This system requires long hauls from the end of the collection route to the disposal site. In this alternative, haul would be by 25 cubic yard compactors with six ton loads and a crew

of three men, as required under existing union regulations. Because of the distance between generation zones and disposal zones, the direct sanitary landfilling system requires an average round-trip haul of two hours from the time the vehicle stops collecting until it begins collecting again. This equals $6 per ton for haul and costs an additional $2.50 per ton for the operation of the sanitary landfill. A Cost Summary is as follows:

Haul to the Sanitary Landfill	$6.00
Cost of the Landfill	2.50
Total Cost/Ton for System	$8.50

A modification of this system entails the use of transfer vehicles for hauling. Compactor vehicles would travel from the end of collection routes to centralized transfer stations at hauls which are somewhat greater than those experienced in the local incineration system. Hauls will average $1.50 per ton, and transfer will cost $2.00 per ton handled.(1) Hauling from the transfer stations with 40 cubic yard vehicles and one-man crews will cost $2.85 per ton or less than one half the per ton vehicle cost of a direct haul. When the $2 transfer cost is added, however, this system appears to be as expensive, if not more expensive, as the direct haul system. Operation of the sanitary landfills will remain

(1) Orange County California Study

the same, $2.50 per ton. A Cost Summary is as follows:

Haul to Transfer Site	$1.50
Transfer	2.00
Haul to Disposal Area	2.85
Sanitary Landfilling	2.50
Total Cost per Ton	$8.85

Regional Incineration

A third alternative is that of a complete regional incineration system in which all refuse is burned, then the residue is placed in sanitary landfills. This alternative need not further be discussed as the savings in land volume will be relatively small (approximately 52,000 acre-feet would be needed) and the amounts of refuse generated in the outer areas are too small to warrant the cost of incineration instead of sanitary landfilling.

Regional Incineration and Landfilling

This system, the one that is recommended, is further detailed later. However, a brief summary is presented here for comparison. The system envisions 9 regional incinerators and 8 sanitary landfills. The incinerators vary from 800 tons to 1800 tons per day, and the sanitary landfills generally will be of moderate size, averaging around 220 tons per day by 1975 and 375 tons per day by 1990.

The regional incinerator costs would be $3.30 per ton at capacity but, allowing for some idle capacity dur-

ing the growth period, the cost averages $4.00 per ton. All of the existing community incinerators will be phased out during the planning period. Because they would be located on or near major expressways and in the center of high refuse production zones, the haul cost to the regional incinerators would average $1.50 per ton. Hauling residue to final disposal in outer sanitary landfills will be in the vicinity of $.95 per ton of refuse delivered to the incinerator.

The Summary for Alternative #4, therefore, is:

Haul to Incinerators	$1.50 per ton
Incineration	4.00 " "
Haul to and Disposal to Sanitary Landfills	.95
	$6.45 per ton

This Alternative is recommended, therefore, because of its efficiencies and because it conserves land (a total system of regional sanitary landfills would utilize 152,000 acre feet of volume, whereas the recommended system uses 73,000 acre feet.

CHAPTER II

RECOMMENDED PLAN AND PROGRAM, 1967-1990

Between now and 1990 it is expected that the volume of waste generated in the metropolitan area will nearly double. The amount of disposable waste will increase from a current 2,650,000 tons to 4,900,000 tons and the ability of the area to dispose of this large anticipated volume of waste will depend upon the area's ability to prepare for it. A plan of operation should consider and evaluate alternatives in terms of organizing existing disposal facilities for immediate needs and of formulating plans for developing, expanding and improving existing and future facilities. Timing is very important in the preparation of engineering plans, bonding procedures, land acquisition proposals and construction. It is necessary to establish a list of priorities which reflects the costs of the various programs in terms of immediate and long range needs.

In the next section of this report, a detailed action program is set forth to serve as a guideline for taking the steps required. The total package envisions capital expenditures of $94 million over the next 25 years and anticipates an average annual cost of $23 million per year for the first five years, including debt service and amortization as well as operating and administrative costs for collection and disposal. The average

annual cost per capita is $8.52, and since the industrial and commercial proportion amounts to about one third of the total, the costs attributable to households would be about $6.00 per year per capita.

As will be seen in the detailed discussions which follow, 9 regional incinerators will be built totalling 10,900 tons of daily design capacity by the year 1990. Regional sanitary landfills are recommended in 8 service areas and their average daily capacity will be about 375 tons per year by the year 1990. The incinerators will handle 80% of the total solid wastes by the year 1990 and the remaining solid wastes, plus the residue will be handled in regional sanitary landfills.

The incinerator construction program is staged over the 25 year period. However, to conserve land and to serve the central communities, five new regional incinerators should be built immediately at a construction cost of $27.3 million.

Sanitary landfills should be started immediately upon engineer site evaluations and an advance land acquisition program which should be directed toward immediate purchase of rights or fees for all potential incinerator and landfill sites. In this plan investigation, visual inspections were done for all potential land available for regional sanitary landfilling in the Metropolitan area. These field investigations did disclose many abandoned sand and gravel pits and quarry holes which could be reclaimed for

future use as ski slopes, golf courses and other uses if they were filled. Complete engineering site evaluation studies were beyond the scope of this plan, however, in those areas recommended as sanitary landfill service areas, enough leeway was provided so that adequate capacity is available even if only half the capacity exists or would be made available. The precise acreage to be acquired for sanitary landfills therefore will vary with the depth or height potential of the specific sites. In this paln, it is estimated that 1900 acres will be needed.

The plan recommends the formation of service areas consisting of groups of communities using the same regional facilities. A possible pattern of service areas, which includes all the communities in the Boston metropolitan area, is presented in detail below. These service areas are delineated on the basis of the generation of solid waste by each community, the proximity of communities to potential regional disposal sites, and the availability of truck transportation routes.

The proposed pattern of service areas is not meant to imply that any community will be compelled to join the regional disposal system. The program recognizes that certain communities with adequate local facilities will continue to use them for many years to come. However, it is expected that over the long term the economics of solid waste disposal will make it attractive for most metropolitan communities to participate in a regional system.

The proposed pattern also is not meant to represent the only reasonable groupings of communities or possible arrangement of facilities. Communities which decide to join the system will have an option in regard to facilities they use. In addition, considerations, such as transportation, may indicate that a particular community's refuse should be delivered in part to one regional facility and in part to another facility. Thus the service areas need not follow community boundaries.

I1 Beverly, Lynn, Marblehead, Nahant, Salem, Swampscott.

Lynn, Nahant, and Swampscott now use the Saugus commercial dump. This facility may be closed at any time. These three communities combined now produce approximately 350 tons of solid wastes per day. There are two incinerators operating in this area, one in Marblehead and the other in Salem. The former (80 tons per day) is adequate for Marblehead's needs but because its storage pit is small this incinerator should be phased out by the middle to late 1970's as it obsolesces. Salem's incinerator has been undergoing extensive alterations which should permit it to more nearly attain design capacity of 230 tons per day; however, the incinerator should eventually be phased out by mid to late 1980's as it ages. The remaining community, Beverly, operates a dump near Route 128 which has a few years of remaining capacity.

The area is now served by Route 1A and Route 107. A proposed Route 128 connector allows Beverly and others to use an expressway for refuse trucks rather than the local streets. It is evident that there is insufficient land available for sanitary landfill for a 25 year period, therefore, a regional incinerator of 1200 tons per day design is recommended. The staging of the action program for these communities is as follows:

Service Area I_1 Beverly, Lynn, Marblehead, Nahant, Salem, and Swampscott.

YEAR	Refuse Tons Disposed	Action
1967	155,000	Operate existing Salem incinerator to capacity. Sanitary landfill the remaining refuse at regional site within service area.
1971		Lynn would temporarily use I3 incinerator until 1975.
1972		Prepare engineering plans for a 1200 ton/day incinerator originally designed and equipped for 800 tons per day and later expanded to 1200 tons per day.
1973		Begin construction of 1200 ton/day incinerator and equip for 800 ton operation.
1975	173,000	Commence operation of 800 ton/day facility on two shifts. Lynn incinerates at I1.
1985	249,000	Add 400 ton/day capacity to the regional incinerator and shutdown the old Salem incinerator. All residue will be disposed of within service area.
1990	261,000	

I_2, L_2: Burlington, Lynnfield, North Reading, Reading, Stoneham, Wakefield, Wilmington, Winchester, Woburn.

Four of these communities use the commercial dump in Saugus which may close anytime. These four, Burlington, Lynnfield, Stoneham, and Wakefield, generate a combined total of 185 tons per day. Another community, Winchester, has an incinerator which can handle 150 tons per day. This incinerator is adequate for Winchester's long range needs but should be phased out as it ages by the mid 1980's. Three other communities, Woburn, Wilmington, and Reading have large remaining capacities in their disposal areas. Reading's dump is located adjacent to Route 128 and there are large tracts of vacant land abutting this facility. North Reading has no facility, and the town's refuse is hauled out of town by a private contractor.

These communities are well served by Route 128 and Routes 28, 93, 38 and 3A. A regional incinerator is warranted here because of a heavy concentration of population and industry that is developing and the need to conserve land for other uses. The area will require a 900 ton per day incinerator and the action program for this area is continued below:

Service Area $I_2 + L_2$

Year	Refuse Tons Disposed	Action
1967	117,000	Communities will sanitary landfill at a central regional facility. Winchester continues to incinerate and dispose of residue at this landfill.
1972		Prepare engineering designs for a 900 ton/day incinerator.
1973	146,000	Begin construction of 900 ton/day incinerator.
1975	163,000	Begin operation of regional facility on a two shift basis. Shut down the Winchester incinerator.
Mid 1980's	185,000	Three shift operation.
1990	219,000	Continue at capacity operation. Residue disposed is within district in sanitary landfill.

I_3: Chelsea, East Boston, Everett, Malden, Melrose, Revere, Saugus, and Winthrop.

Seven of these communities* are using the commercial dump in Saugus. The seven currently produce a total of about 660 tons per day. The other community, Winthrop, has its own dump which is currently at capacity. Melrose and Saugus have municipal dumps but they are of limited capacity and used to handle the week-end loads. The commercial dump in this area, off Route 107 in Saugus in the Saugus Marshes, has been serving 16 communities and many large industries, institutions and individual contractors in the Boston area for several years. Because it is in a coastal marsh which is a valuable area for wildlife protection and production, the State's Department of Natural Resources has set limits on the area which can be filled. This area is nearing exhaustion as a dumping ground.

The 8 communities in this area north of the Mystic River are served by Routes 1, C_{II}, 1^A, 107, north and south; and by the Revere Bearch Parkway and Route 60, east and west. Programmed improvements of Route 95, an interstate highway which will pass through the area will improve north-south traffic flow even further.

There is very little land available in this area for sanitary landfill. Those marshlands and wetlands which are valuable

*East Boston is not a corporate body but a part of the City of Boston. However, by geography, East Boston is more nearly allied in this proposed service area with the named communities.

for flood control and wildlife production and protection should be preserved from filling. Therefore, the concentration of population and industry and the absence of land for sanitary landfilling requires a 1200 ton per day incinerator. Because the whole area, practically is dependent on the Saugus commercial dump, the construction of this incinerator should be given immediate priority. During the early years, because there will be some excess capacity, the city of Lynn (currently 315 tons per day) should also be served by this incinerator, then phased into the I_1 incinerator to the north as that is built. Other communities such as Charlestown, Medford, Stoneham and Wakefield may use this incinerator while it has the capacity.

Service Area I_3

Year	Refuse Tons Disposed	Action
1967	181,000	District continues to use existing facility and regional landfill located in L_1.
		Prepare engineering designs for 1200 ton/day incinerator
1969		Begin construction of 1200 ton per day incinerator.
1971	285,000	Begin operation of incinerator on 3 shifts and include Lynn, Nahant and Swampscott until 1975.
1990	294,000	Continue 3 shift operation. Dispose of residue at regional sanitary landfill in L_1

I_4: Arlington, Belmont, Cambridge, Charlestown*, Medford and Somerville.

The latter two of these listed communities use the commercial dump in Saugus. Medford currently hauls its burnables to the incinerator in Somerville and the residue from the incinerator is then trucked to the Saugus facility. Medford's non-burnables are also hauled directly to Saugus. There are municipal incinerators existing in Belmont (150 tons per day), Cambridge (200 tons per day), and Somerville (450 tons per day). The Belmont (built in 1959) and Somerville (built in 1961) incinerators are adequate to serve those communities' long range needs. Both incinerators should be phased out by the mid-1980's as they age. The Cambridge incinerator is 29 years old and the City is considering replacing it. Charlestown, part of the city of Boston, currently is served by Boston's South Bay incinerator. In the long range picture, Charlestown should be viewed as part of this I_4 service area because South Bay's site limitations preclude any incinerator of larger than 1200 tons per day design (to be discussed later), and because projected highway improvements will reinforce the inclusion of Charlestown with the I_4 communities. Arlington, the remaining community in the area has had considerable success with sanitary landfills on small parcels of land which by nature

*Charlestown is not a corporate community but a part of the city of Boston; because of its geography it is included in this service area.

are short-lived operations. Their current operation is nearing its end and only limited potential is left in this town for additional sanitary landfills.

This I_4 service area is traversed by the east-west Route 2 which is being upgraded to a limited access highway, by the Alewife Brook Parkway as it runs north-south, and by numerous secondary highways. The projected extension of Route 2 to the Inner Belt will greatly assist traffic flows in this service area.

This service area produces heavy residential and industrial solid waste tonnages and has no potential for sanitary landfill operations to speak of. The area needs a modern, highly efficient incinerator plant of 1600 tons per day design. Nearly half of that capacity is needed immediately to serve the communities of Arlington, Cambridge, Charlestown, Medford. As the Belmont and Somerville incinerators are phased out, the additional 800 tons will be needed.

Service Area I_4

Year	Refuse Tons Disposed	Action
1967	242,000	Use existing facilities and prepare engineering designs for a 1600 ton/day incinerator to be originally equipped for 800 tons per day and expanded to 1600 tons/day later.
		Prepare engineering designs and specifications for a 1600 ton/day incinerator.
1969		Begin construction of 1600 ton/day incinerator and equip it for 800 tons per day.
1971	252,000	Begin operation of 800 ton/day incinerator on a 3 shift basis.
1981	308,000	Add 800 ton to the regional incinerator.
1986	354,000	Municipal facilities existing in this area should be phased out of service area by this time. Handle all refuse at 1600 ton incinerator.
1990	378,000	Continue operations with residue disposed at I_2 sanitary landfill.

I_5, I_6: Allston-Brighton*, Brookline, Newton, Needham, Waltham, Watertown and Wellesley.

All of the communities in this group are served by existing municipal incinerators, except Needham. All incinerators are relatively new, their total designed capacity is 1450 tons per day which capacity, if utilized, would be adequate at least up to the year 1980 when a new regional facility should be considered. All of the dumps or ash residue areas in this area present either existing or potential problems to the brooks and streams and to the Charles River and steps should be taken to close the dumps.

The area is traversed by a number of major routes and secondary highways including the Massachusetts Turnpike, Routes 20, 9, 16, and Route 128.

There are no potential sanitary landfill areas of regional consequence in this I area and, therefore, the plan recommends inter-community use of existing incinerators before any new regional capacity is built. Eventually, by the early 1980's, a regional incinerator may be needed. This incinerator would require an 800 tons per day and a design that is expandable to 1600 tons per day later. The action program for this area is as follows:

*Allston-Brighton is not a corporate community but a part of the city of Boston. It is included here because of its geography.

Service Area $I_5 + I_6$

Year	Refuse Tons Disposed	Action
1967	250,000	Intercommunity use of existing facilities to serve the entire district.
1971	292,000	All existing facilities operate on 3 shifts.
1978		Prepare engineering designs and specifications for a 1600 ton/day incinerator.
1979	330,000	Begin construction of 1600 ton regional incinerator and equip for 800 tons per day.
1981	341,000	Place 800 ton/day facility in operation and close the Brookline and Wellesley incinerators. Merge service areas I_5 and I_6 and close the Wellesley incinerator, directing refuse to the regional facility.
1984		Add 800 tons/day to regional incinerator.
1986	271,000	Place additional capacity in operation for a total of 1600 tons/day at the regional incinerator. Close the Watertown incinerator.
1990	390,000	Shut down the Newton incinerator and direct refuse to 1600 ton incinerator. Residue disposed in service area L_4 sanitary landfill.

I7: Ashland, Framingham, Natick and Sherborn.

These four communities are at the western edge of the Metropolitan area as defined in this plan. Framingham and Natick are largely developed and have heavy concentrations of commercial and industrial solid wastes in addition to the normal household refuse. Framingham has an incinerator (1954 equipment, the building was much earlier) which is rated at 200 tons per day but because of limited storage area it has far less capacity for the second shift and practically none for the third. The incinerator is a unique continuous feed design with water-cooled furnaces, the first to be built in the metropolitan area. Framingham's able public works staff has developed and improved this incinerator well beyond its original conception but its age, the age of the building, and its limited storage indicate that it should be replaced in the near future. Framingham recently purchased 46 acres for a sanitary landfill in the northwest corner of town, which should serve their needs for a few years. The Natick and Sherborn dumps adjoin each other at the towns' boundary lines. They have ample capacity except they are located in or near wetlands of the Charles River Flood Plain. Ashland has ample capacity in its dump and there are numerous sand and gravel pits in the area.

Framingham and Natick are served by the east-west highways, Route 9 and the Massachusetts Turnpike, Routes 135, Route 27 and 126 connect the towns of Ashland and Sherborn with Framingham and Natick.

The program calls for an incinerator large enough to serve at least the needs of Ashland, Natick, and Framingham; Sherborn's projected tonnages are so small--7 tons per day in 1990--that their needs could be much more efficiently served in a regional facility. Therefore, for this area, an incinerator of 800 tons per day is programmed for the early 1970's. Before any site is selected for this facility, very careful consideration should be given to the transportation of refuse in this area.

The action program for this area is as follows:

Service Area I_7

Year	Refuse Tons Disposed	Action
1967	85,000	
1972		Prepare engineering design and specifications for an 800 ton/day incinerator.
1973		Begin construction of 800 ton/day incinerator.
1975	110,000	Begin operation at regional incinerator on 2 shifts. Shut down the Framingham incinerator.
1988	135,000	Start 3-shift operation at the regional incinerator.
1990	155,000	

I_8: Boston (excluding Allston-Brighton, Charlestonwn, East Boston), Dedham, Milton, Norwood and Westwood.

There are two existing incinerators in this group: in Boston (the South Bay incinerator) 900 tons per day, and in Dedham, 100 tons per day. The South Bay incinerator generally operates 20 out of 21 shifts per week. It was built in 1959 and the City is presently planning some modifications and alterations to it. Dedham's incinerator is six years old and continues to operate well although the disposal of bulky materials presents a problem to the town at the moment. The Dedham incinerator is adequate to serve the long range needs of the Town but should be phased out in the mid 1980's as it ages. Parts of Boston such as West Roxbury, Roslindale, and Hyde Park utilize the Gardner St. landfill. This site is one of the last remaining large parcels of vacant land in the city. It is located near the Charles River and the Boston-Newton line. The Gardner Street facility is somewhat inaccessible for trucks because there are several parkways in the area which must be avoided. There are two other disposal sites in the area. Norwood has a dump located on the Norwood-Westwood line and there have been some proposals in the past to construct an incinerator at this location. The Norwood dump is filling rapidly and there are few areas in town that are considered to be available for sanitary landfill. Milton has a landfill operation which is adequate for 15 or more years of operation. The remaining town, Westwood, has no facility -- a contractor collects and

hauls the refuse outside of the metropolitan area.

This area is traversed by the north-south Routes, 28, 138, Washington St. which heads south west from the city of Boston to Route 1 in Dedham, Route 1, Route 95, Route 109, and Route 128. Route 95, an interstate highway will be extended from its present terminus at Route 128, directly into downtown Boston where it will connect with Route 695 (the Inner Belt). This extended Route 95 will assist traffic flows in the Roslindale, West Roxbury and Hyde Park sections of the City and will assure easy transportation to the south west.

Recommendations for this area include reconstruction or alteration of the South Bay incinerator to 1200 tons per day design and construction of an 1800 ton per day central incinerator to serve south west Boston and the communities of Dedham, Milton, Norwood and Westwood. Residue from this incinerator would be hauled to sanitary landfills to the south west. The action program for this area is as follows:

Service Area I_8 Boston (excluding Allston, Brighton, Charlestown, East Boston), Dedham, Milton, Norwood and Westwood.

Year	Refuse Tons Disposed	Action
1967 or 1968	535,000	Prepare engineering designs for a 1200 ton/day incinerator and an 1800 ton/day incinerator initially equipped for 1200 ton/day.
1969		Rebuild South Bay incinerator to 1200 ton/day and begin construction of an 1800 ton/day facility to be initially equipped for 1200 tons.
1971	588,000	Begin operation of two 1200 ton/day incinerators.
1974		Add 600 tons per day of capacity to the district's new incinerators.
1975	617,000	Place the additional 600 tons of capacity in operation and operate both incinerators on 3 shifts. Phase out Dedham incinerator.
1985	710,000	When its sanitary landfill is exhausted Milton will dispose at the regional facility.

I_9: Braintree and Quincy.

The town of Braintree operates an open dump adjacent to Route 3, a major expressway to the South. The dump has been estimated to have approximately 2½ years of remaining capacity and the town lately has been considering an incinerator. Quincy has been filling abandoned granite quarry holes and the most recent area, Lower Fallon's Quarry, is nearly full. Quincy's quarry holes are not inexhaustable and should be conserved by building an incinerator and filling the quarries with the residue.

The communities are traversed by the Southwest Expressway (Route 3) and Route 128 and several lesser highways and secondary roads. Recommended action to serve these communities is the construction of a 600 ton per day incinerator. The residue may then be conveniently used as an excellent fill material which will insure that the old abandoned granite pits can be reclaimed for future use. It is possible that later on Milton, Holbrook and Randolph may be included in the regional incinerator and that expansion of the incinerator would be required. The recommended action program for the communities is as follows:

Service Area I_9 Braintree, Quincy.

Year	Refuse Tons Disposed	Action
1967	83,000	The service area should acquire a regional sanitary landfill site and operate for disposal of all refuse.
1968		Prepare engineering designs and specifications for a 600 ton/day incinerator.
1969		Begin construction of 600 ton/day incinerator.
1971	99,000	Place 600 ton/day facility in operation and operate on 2 shifts.
1975	108,000	
1983	125,000	Operate regional incinerator on 3 shifts.
1990	140,000	Continue on 3 shifts and dispose of residue at disposal site within the service area.

L-1 Danvers, Hamilton, Manchester, Middleton, Peabody, Topsfield and Wenham.

All of the communities in this service area with the exception of Wenham are served by local dumps. Wenham has a private contract for collection and disposal of its wastes outside of town. Of the remaining communities, Hamilton and Manchester operate separate, but adjacent dumps, which under present operating conditions will serve until the early 1970's. The dumping areas in Topsfield and Danvers will be exhausted by the late 1960's, while the site in Middleton has additional abutting acreage. The facility in Peabody has the capacity to operate until the early 1980's. If these facilities are to be continued, they must be converted to sanitary landfills.

By 1990 total acre feet required for these communities will be 5250, while existing capacities will only provide 1160 acre feet. Existing facilities and potential regional sites, such as abandoned pits, in the area have a total capacity which is well in excess of this area's needs.

This service area is traversed by the major highway networks of Route 128 and Interstate 95. A regional landfill, located in the Peabody-Danvers vicinity, would be accessible from all communities in the area. By 1990, these communities will need a landfill capacity of 500 tons/day.

L-1 Danvers, Hamilton, Manchester, Middleton, Peabody, Topsfield and Wenham.

Year	Annual Refuse Tonnages Disposed	Action
1965	59,400	
1967		Service area communities continue to use existing facilities.
1968		Negotiations to acquire site for regional sanitary landfill operation.
1969		Make capital improvements to site and prepare for operation. Commence operation as soon as practical.
1975	87,900	Operations will average 290 tons per day for 300 days per year.
1990	146,000	Operations will average 500 tons per day for 300 days per year.

L-3 Bedford, Concord, Lexington and Lincoln.

The communities in this service area with the exception of Lexington are served by open dumps. Lexington's landfill has sufficient capacity through 1990. The dumps in Lincoln and Concord will be exhausted by the late 1960's, and while the Bedford dump has more remaining capacity, the town is searching for alternative disposal possibilities. The total existing capacity for this area is 1100 acre feet. Yet by 1990, 3500 acre feet will be needed. With the use of existing facilities and potential sites the area has more than double its projected need.

The present dump in Lincoln is within the site to be used as a national park and will have to be eliminated in several years. The acquisition of a centrally located landfill site within this service area would be desirable. The area is served by Route 2, which is being updated to a limited access highway, and Route 128. A regional sanitary landfill in this area will alleviate the pressure upon existing facilities, reduce some of the current nuisances, and result in economies. By 1990 these communities will need landfill facilities which will be able to accommodate 350 tons per day.

L-3 Bedford, Concord, Lexington and Lincoln

Year	Annual Refuse Tonnages Disposed	Action
1965	51,200	
1967		Service area communities continue to use existing facilities.
1968		Negotiation to acquire site for regional sanitary landfill operation.
1969		Make capital improvements to site and commence operations as soon as practical.
1975	72,400	Operations will average 240 tons per day for 300 days per year.
1990	107,300	Operations will average 350 tons per day for 300 days per year.

L-4 Sudbury, Wayland and Weston.

This service area is now served by three dumps, two of which are owned and operated municipally and one which is privately owned. All three facilities will be exhausted by the end of this decade. The existing acre feet capacity is only 150, and by 1990 there will be a demand for 1900 acre feet. Within the area there is a large potential in an abandoned gravel pit, which is suitable for regional sanitary landfilling. Since existing facilities are soon to be exhausted and are located close to water sources, it is recommended that a new location be found. These communities are already talking about regional disposal facilities.

A regional grouping is natural for this area and existing highway systems make a central landfill feasible. The area is served on the periphery by Route 128 and the Massachusetts Turnpike and internally by a secondary road network including Routes 20, 37, 117 and 126.

By 1990 these communities will need a landfill facility to handle 200 tons/day. An alternative for Weston at later date may be to use the regional incinerator in the I_5 area.

L-4 Sudbury, Wayland and Weston

Year	Annual Refuse Tonnage Disposed	Action
1965	23,400	
1967		Service area communities continue to use existing facilities.
1968		Negotiations to acquire site for regional sanitary landfill operation.
1969		Make capital improvements to site and commence operations as soon as practical.
1975	36,000	Operations will average 120 tons per day for 300 days per year.
1990	59,300	Operations will average 200 tons per day for 300 days per year.

L-5 Dover, Medfield, Millis, Norfolk and Walpole.

This service area will need approximately 2150 acre feet of sanitary landfill capacity to serve its needs through 1990. All five communities operate open dumps, which contain a total of 214 acre feet of capacity or 10 per cent of the 1990 need. The area can be served either by one or two large regional landfills or several community landfills, because there is a large amount of vacant land in the area.

Substantial disposal savings ($2.80 as opposed to $5.32 per ton) can be achieved, however, by regional landfills without excessive haul costs. Haul to a central landfill site can be accomplished within an average roundtrip time of less than 49 minutes or $3.00 per ton. The haul associated with community disposal within the five communities averages 25 minutes or $1.88 per ton. Therefore regional disposal will result in savings of $1.78 per ton. Present tonnages require a landfill having 85 tons per day capacity and 1990 tonnages will require 240 tons of capacity.

This area is served by several major roads including routes 1A, 115, 27 and route 109. Because there are several possibilities in this area, a readjustment of the area to be served is dependent on the location of the particular sites and their relation to transportation facilities. The same consideration holds true for the next area, L_6.

L-5 Dover, Medfield, Millis, Norfolk and Walpole.

Year	Annual Refuse Tonnages Disposed	Action
1965	24,500	
1967		Service area communities continue to use existing facilities.
1968		Negotiations to acquire site for regional sanitary landfill operations.
1969		Make capital improvements to site and commence operations as soon as practical.
1975	37,400	Operations will average 125 tons per day for 300 days per year.
1990	73,100	Operations will average 240 tons per day for 300 days per year.

L-6 Canton, Holbrook, Randolph, Sharon and Stoughton.

The communities in this service area will require approximately 5000 acre feet of disposal capacity by 1990. Existing facilities have 2200 acre feet of capacity remaining and therefore at least 2800 acre feet of capacity is needed. Randolph has substantial capacity at its existing landfill. Stoughton has exhausted its present dump and is piling refuse well above grade. Two communities, Canton and Sharon, will also have exhausted their dumps by 1975. Holbrook has sufficient capacity for its own needs through 1990, provided the facility is converted to a landfill. Large potential capacities for sanitary landfills exist in this area in several large abandoned sand and gravel pits.

To provide adequate capacity for the service area until 1990, regional sanitary landfills would be needed to handle approximately 180 tons per day at present and 425 tons per day by 1990. It is also recommended that the sanitary landfills accept ash residue from the I-8 incinerators as this will provide substantial cover material at no cost, if they join a regional system.

North-south transportation routes, such as 24, 28 and 138, and east-west routes, such as 27, are excellent and will allow all roundtrip hauls within the region to be accomplished in 45 minutes or less. Because there are several alternatives in this area, as in L_5, a readjustment may occur in the areas

L-6 Canton, Holbrook, Randolph, Sharon and Stoughton.

Year	Annual Refuse Tonnages Disposed	Action
1965	52,000	
1967		Service area communities continue to use existing facilities.
1968		Negotiations to acquire sites for regional sanitary landfill operation.
1969		Make capital improvements to sites and commence operations as soon as practical.
1975	78,700	Operations will average 260 tons per day for 300 days per year.
1990	127,600	Operations will average 425 tons per day for 300 days per year.

L-7 Cohasset, Hanover, Hingham, Hull, Norwell, Rockland, Scituate and Weymouth.

The communities in this service area need approximately 6000 acre feet of capacity for refuse disposal to 1990. While capacity in present facilities is 3000 acre feet, it includes disposal sites located in tidal marshes and well fields. These sites may not be permitted to continue because of existing State legislation. The eight communities within the area operate seven open dumps, one sanitary landfill (Hingham) and one incinerator (Weymouth). With the exception of Cohasset, all dumps and the landfill will be exhausted by 1975. Two dumps, Hull and Rockland, will run out of capacity before 1970, and many others will find it costly to convert and operate community landfills.

A regional landfill is recommended for the area. The proposed site for disposal operations is centrally located and has sufficient capacity to dispose of all refuse until 1990. The Weymouth incinerator, built in 1965 with a capacity of 300 tons per day, is more than adequate to serve that town for the next twenty-five years. Transportation difficulties, however, limit the intercommunity use of this incinerator. Disposing of all refuse, including the residue from Weymouth's incinerator, in a central sanitary landfill requires at present a capacity of 200 tons per day, which will increase by 1990 to 700 tons per day. The proposed new Route 128 connector will enable coastal communities to reach a central site in this area.

L-7 Cohasset, Hanover, Hingham, Hull, Norwell, Rockland, Scituate and Weymouth.

Year	Annual Refuse Tonnages Disposed	Action
1965	78,700	
1967		Service area communities continue to use existing facilities.
1968		Negotiations to acquire site for regional sanitary landfill operation.
1969		Make capital improvements to site and commence operations as soon as practical.
1975	118,000	Operations will average 395 tons per day for 300 days per year. Weymouth will continue to incinerate.
1990	210,000	Operations will average 700 tons per day for 300 days per year at the sanitary landfill. Weymouth's incinerator will be phased out and the refuse will go direct to the landfill.

L-8 Duxbury, Marshfield and Pembroke.

The communities in this service area will require 1750 acre feet for refuse disposal to 1990. At present the area is predominantly residential with low population densities. Present facilities are open dumps with a total capacity of 325 acre feet or 20 per cent of the acre feet needed to 1990. While potential disposal sites exist in the communities, it would prove costly (in excess of $5.00 per ton handled) to operate independent community sanitary landfills. Furthermore, substantial savings can be realized when refuse in excess of 100 tons per day are handled at one facility. A 100 ton a day sanitary landfill can operate at $2.90 per ton. Transportation routes within the area are principally the north-south routes of 3 and 3A.

Potential central sanitary landfill sites for the area do exist and could serve its needs for the planning period. Recent demands will require a 45 ton per day capacity and projected demands will require a capacity of 210 tons per day in 1990.

L-8 Duxbury, Marshfield and Pembroke.

Year	Annual Refuse Tonnages Disposed	Action
1965	12,400	
1967		Service area communities continue use of existing facilities.
1968		Negotiations to acquire sites for regional sanitary landfill operations.
1969		Make capital improvements to landfills and begin operations as soon as practical.
1975	24,000	Operations will average 80 tons per day for 300 days per year.
1990	64,900	Operations will average 210 tons per day for 300 days per year.

CHAPTER III

THE ADMINISTRATION AND FINANCING OF THE REGIONAL SYSTEM

Implementation of this recommended solid waste disposal plan requires immediate actions that are organizational and administrative, technical, financial and legislative. The program recommendations concentrate on the first five years of the plan, however, continuing long-range implementation is required and the mechanism for updating of the program is included in the recommendations which follow.

1. Organizational and Administrative Recommendations

Background for Decision-Making. The results of the Council's investigations as set forth in this report are for the prime purpose of providing a factual background for decision-making by the General Court and the cities and towns in the metropolitan area. The report is intended to assist the many municipalities in evaluating not only the needs and urgencies of the solid waste disposal problem, but also the relative feasibility and desirability of the solutions available. The plans and programs developed in the report need to be implemented by a carefully-prepared schedule of activities. Several recommendations require immediate action.

Metropolitan Area Solid Waste Administration. Administration of the solid waste collection and disposal program is the first decision to be made.

The advantages of the regional approach are described in detail in another section of the report.

The program recommends that the overall management be vested in an existing central agency with local service areas being administered by resident supervisors. This, in effect, means the creation of a solid waste agency to serve the 79 municipalities comprising the Metropolitan Area Planning Council. The agency should have field offices located at each metropolitan waste disposal facility, be it an incinerator or a sanitary landfill.

An initial decision, undoubtedly, is whether to create a wholly new solid waste agency or to expand the authorization of an existing department, commission or authority. The creation of a new agency has little to offer, if an existing agency has the requisite administrative personnel and technical experience. The expansion of an established agency would build upon existing capabilities in providing similar public services.

The obvious choices for ar existing central agency are the Massachusetts Department of Public Works, the Building Construction Bureau of the Administration and Finance Department, the Department of Public Health or the Metropolitan District Commission. Only the DPW and the MDC now have responsibilities for both operating and construction activities. The DPW is presently charged with highway and waterway construction and operation for the entire state. The MDC has responsibilities for the construction and operation of parks, parkways, water

supply and sewerage disposal for the major portion of the population residing in the area included in the Metropolitan Area Planning Council.

The MDC already has much of the capabilities needed to administer, manage, and operate a solid waste collection and disposal program for the metropolitan area. Prior to the formation of the MDC, the needs of various municipalities for park, water and sewerage facilities far exceeded the resources of the communities now within the district. The very same condition relative to needs now exists with respect to solid wastes. In fact, it is this circumstance which prompted this particular areawide comprehensive plan and program.

A statewide system appears to have little merit as there are substantial rural areas separating major metropolitan areas, such as Springfield and Worcester, which would derive little benefit from such a system. The creation of separate metropolitan area solid waste agencies, where needed, appears to offer a sounder basis for the organization of disposal services.

Organization of Solid Waste Agency

The expansion of the MDC to provide solid waste disposal services should evolve from an in-depth management review performed by that agency. However, certain definite requirements can be stated at this time.

(1) The MDC should be expanded to provide solid waste services to all of the communities that are included in this metropolitan plan and program. Provision for new memberships for adjacent municipalities should require acceptance by a majority vote of the constituent cities and towns.

(2) Supervision of collection and disposal facilities in the various service areas should be provided by new MDC field offices. These would provide, as well, a local point of contact for receipt and implementation of corrective action on any complaints relative to collection or disposal operation.

(3) The MDC headquarters in Boston should provide the same administrative and engineering support that it now provides for its several other activities. It is expected that the MDC would have powers for bonding, eminent domain, and levying of charges or assessments to constituent municipalities for solid waste services, similar to its existing authorizations.

(4) Provision should be made for member communities to have a strong voice in determining metropolitan solid waste disposal / policies through the establishment of an MDC Solid Waste Disposal Advisory Board. This Board should consist of elected officials or city or town

managers (or their designees) from each member community. The Board should have the right to review and and approve annual capital and operating expenditures, and the assessment of costs for the Commission's solid waste disposal services. Special meetings should be held, as needed, to review and approve the Commission's solid waste disposal plan and development program. The plan and program should include the location, type and size of facilities to be built, acquired or reconstructed; the schedule for acquisition, construction, reconstruction or alteration and the estimated costs of such facilities, and the methods and procedures for financing and allocating the costs. The plan and program should be reviewed and updated annually by the Commission and an annual report should be prepared by the Commission and submitted to the Governor and the General Court. The contents of this annual report, in addition to an account of current operations, should include a summary of the Commission's solid waste disposal development program and capital budget as most recently approved by the Advisory Board and covering the forthcoming budget year and the ensuing five-year period.

(5) Critical skills are needed to implement this plan and program. It is recommended, therefore, that in addition to a Director of Solid Waste Disposal and his administrative and clerical staff, the headquarters of the division should include a Chief Sanitary Engineer and a Budget Specialist. The latter two persons would be primarily responsible for revising the program and developing the capital budget. These are extremely important position which should be filled with highly-qualified individuals who will insure that a continuing development program is followed. It will also be their responsibility to see that the Commission keeps abreast of technological developments and ahead of the solid waste disposal needs of member communities.

(6) The Commission's primary responsibility should be to provide a high level of solid waste disposal service for its member communities. This may be done either by Commission-operated or contractor-operated facilities. The merits of both methods should be determined upon engineering studies, the setting of outline specifications and the submission and evaluation of contractor bids.

(7) Responsibility for refuse collection may rest with the individual communities, if they desire. The Commission should continue to work with those communities that are served by regional facilities towards the establishment of rules, regulations, and standards -- depending on the particular design of the disposal facility -- for the type and size of delivery vehicles and containers, the times for delivery, and the types of materials to be accepted.

(8) An advance land acquisition program should be initiated by the MDC as soon as is practicable. This acquisition program should include a sanitary engineering evaluation of each site prior to its acquisition. The acquisition program should take advantage of all available state and federal assistance programs, including the technical assistance programs of the U. S. Public Health Service, the U. S. Geologic Service, the U.S. Soil Conservation Service, and the

federal-aid provisions of the Departments of Housing and Urban Development and Health, Education and Welfare.

(9) The Massachusetts Department of Public Health, through its Sanitary Engineering Division, should review the adequacy, from a public health standpoint, of the solid waste disposal facilities provided by the MDC.

(10) The Massachusetts Department of Natural Resources should review proposed solid waste disposal sites in terms of the compatibility with water resource development, water pollution control requirements, wetlands legislation, and recreation planning.

(11) The Metropolitan Area Planning Council, as the official regional planning agency for the Boston area, should review proposed solid waste disposal sites from the viewpoint of their conformity with comprehensive regional development plans and specific regional functional plans.

Financing the Program: 1968-1972

The total costs for administering the program and operating new facilities, including the capital costs to be amortized annually, will reach $26 million per year during the period 1968-1972. These costs are subdivided into an administrative and operating budget and a capital budget. An estimate for refuse collection costs and for continued operation of municipal refuse disposal facilities is also included.

(1) Administrative and Operating Budget

Administration of the Metropolitan District Commission's program will require an estimated $400,000-$500,000 per year during the period 1968-1972, depending on the number of communities who decide to use regional facilities. Approximately 80 per cent of the cost will be for salaries and wages plus allowances for vacations, sick leave, retirement, insurance and other benefits. The central headquarters personnel anticipated in this estimated budget are a Director-Chief Engineer, a Deputy Chief Engineer, and an engineering, budgeting, and clerical staff of seven persons. Also included in the budget estimate are the supervisors and clerical staff who would begin coordinating and implementing the program at the seventeen proposed area field offices. Approximately 20 per cent of the cost will be for central office space, stationary, office equipment, automobiles and similar expenses.

Operating costs for new facilities, which would not be incurred until 1970 or 1971, are estimated to average $2,600,000

per year at all five new regional incinerators. This cost includes an estimated $1,700,000 for labor, $560,000 for fuel, electric power, water and supplies, and $300,000 for maintenance and repairs at the five incinerators. (These figures are at today's cost index.)

At the eight regional sanitary landfills the operating cost will be approximately $880,000 per year. This estimate includes costs for purchase of cover materials (including an adjustment for using incinerator residues from existing and new incinerators), labor and equipment operations, and maintenance.

Existing local incinerators and local dumps converted to sanitary landfills, which will continue to operate will cost an estimated $7,000,000 annually for both operating and capital costs.

Finally, combined refuse collection in all communities is estimated at $13,500,000, an average of only $5 per capita per year. This collection cost is $4.1 million higher than the currently reported collection costs, but it represents a much higher level of service for communities that currently receive partial collection or no collection.

In summary, the administrative and operating budget will increase, but the cost per ton will decrease as more service is provided and more tonnage is handled in the metropolitan system. By 1971 the five regional incinerators will be in operation.

Annual costs for capital improvements, local collection, and facility operations will increase to $26,000,000, and should remain at this level through 1975.

(2) Capital Budget

The capital budget in the first five years anticipates large outlays for advance land acquisition and for incinerator construction. These actions are needed to assure immediate and long-term capacity for solid waste, disposal in all service areas.

The incinerator cost figures include the cost of air pollution devices which will meet the strictest standards of air pollution control. A breakdown of the initial five-year capital budget is as follows:

CAPITAL OUTLAYS, 1967-1972

Acquisition of approximately 1900 acres of land for 8 Sanitary landfill service areas	$25,000.000
Acquisition of approximately 100 acres of land for 9 central incinerator sites	2,600,000
Improvement and starting costs for 8 sanitary landfills	7,850,000
Engineering and construction for one-600 ton per day incinerator, two-1200 tons per day, one 600 tons per day and one 1800 per day.	$22,870,000
TOTAL CAPITAL OUTLAYS	$58,320,000

The foregoing capital outlays would be met by general obligation bonds and at an assumed interest rate of four per cent. The annual principal and interest cost would be $5,250,000in 1968 when the first payment became due, $5,132,000 in 1969, $5,016,000 in 1970, and $4,899,000 in 1971.

(3) Total annual anticipated expenditures in the first five years, 1968-1971, including the operating costs and annual amortization and debt service on the capital budget are summarized in the following table:

TOTAL BUDGET: SOLID WASTE SYSTEM, 1968-1972

Item Year:	1968	1969	1970	1971	1972
Administrative staff, office, and supplies	$ 563,000	$ 563,000	$ 563,000	$ 563,000	$ 563,000
Community incinerators, operation, principal and interest	3,300,000	3,300,000	3,300,000	3,300,000	3,300,000
Local dumps converted to sanitary landfills	3,800,000	3,800,000			
Regional incinerator operating costs				2,585,000	2,585,000
Regional sanitary landfill operating costs			880,000	880,000	880,000
Total Operating Cost, Disposal	$7,663,000	$ 7,663,000	$4,743,000	$ 7,328,000	$ 7,328,000
Amortization and debt service on $59,340,000		5,340,000	5,222,000	5,100,000	4,990,000
TOTAL DISPOSAL COST	$7,663,000	$13,003,000	$9,965,000	$12,428,000	$12,318,000
MUNICIPAL COLLECTION COST*	$9,366,000	$ 9,366,000	$13,500,000	$13,500,000	$13,500,000
TOTAL SYSTEM COST	$17,029,000	$22,369,000	$23,465,000	$25,928,000	$25,818,000

* In this line the $9,000,000 figure represents costs reported by communities which currently provide collection. The $13,500,000 figure represents the estimated costs of local collection for the entire metropolitan area, if all communities instituted this service.

Assessment of Costs

The costs of the metropolitan solid waste disposal system should be borne by communities, businesses, and industries using the regional facilities. Assessments should be determined after all Federal and State grants have been subtracted from the annual costs for administration, operations, maintenance, and amortization of facilities. Accurate records must be kept of all costs, all revenues, and all solid wastes received from members and other users. The immediate question, which is likely to be raised, is how will the capital and operating costs of the system be assessed on member communities and other users. The following discussion is intended to set forth general guidelines rather than detailed formulas for the allocation of charges.

All 79 communities should share the cost of central administration and research for the metropolitan solid waste system in an amount not to exceed $100,000 per year. Such costs should be paid whether or not a community uses a regional facility, because the central administrative and research staff will continuously program new facilities and explore new technologies to meet the future needs of all member communities.

All capital and operating costs for the Commission's facilities should be shared by the member communities which use these facilities. The assessment of costs should be based on

actual service rendered as determined by the tonnage delivered by each community and the type of facility provided.

It may be necessary to charge an entrance fee for new members to cover the cost of capacity provided for their use. Once accepted for membership they will be assessed for administrative research, capital and operating costs as described above.

Non-member and commercial and industrial firms and their contractors should be charged for capital and operating costs on a per ton basis. The rate for using the commission's facilities may be higher than the rate set for members, because it will include the portion of capital costs of the facility designed to accommodate their estimated needs.

Areas of Proposed Legislation

Metropolitan District Commission

In order to implement the recommended plan and program legislation is needed designating the Metropolitan District Commission as the agency to establish a waste disposal system for the metropolitan area. Several points, which were set forth in the program section, should be included in the legislation. First, the MDC should be authorized to provide services to those of the 79 metropolitan communities which choose to join the system. Second, each individual community should have a voice in disposal operations through a Solid Waste Advisory Board.

Third, the MDC should establish field offices in each service area to operate the regional disposal facilities and to provide direct communication with member communities. Fourth, the MDC should have the powers to acquire land, to enter into contracts, to construct, manage, maintain and operate facilities for the disposal of solid wastes, to issue bonds for the purposes of providing solid waste services, and to assess members and users for charges for services.

State Aid

Legislation is needed to establish a program of State financial aid to regional solid waste disposal agencies throughout the Commonwealth. Because approved disposal facilities are costly, a state aid program will provide the necessary incentive for the development of a uniformly high levels of disposal service. The quality of service provided is directly dependent on the design of the facility, its proper equipping and supervision, and its architectural treatment. Although Federal assistance is available, these programs are limited and aid is often given in the form of a reimbursement of local expenditues.

State aid should be provided in the form of grants to official regional disposal agencies for capital improvements. Grants should be available for the construction and equipping of incinerators, sanitary landfills, and other acceptable facilities. This aid should include site acquisitions, access

roads, fencing and screeing, water lines, storage facilities, bulldozers, trucks, and cranes directly used at regional facilities. It is particularly important that air pollution control devices for incinerators be considered an eligible item.

The amount and type of aid should be a capital grant, representing at least 30 per cent of project costs, on items certified as eligible by the Department of Public Health. It should be paid annually by the State Treasurer to regional disposal agencies over the use life of their facilities. In addition, these grants should be applied to the assessments of costs on the users of the regional solid waste facilities.

In conjunction with the state aid program the MDPH should be required to outline minimum design standards, specifications, and operating techniques for all solid waste facilities. Continuing state grant payments should be contingent upon approval of a facility's operations by annual MDPH inspections. MDPH will probably require additional personnel in order to administer an effective state-aid program.

Open Dumping

One of the most important recommendations of this report states that all open dumping should be prohibited and that within six months disposal facilities should conform to standards

established by the MDPH. Legislation is needed in order to effect this recommendation. The most obvious reason for such legislation is the fact that open dumps are intolerable and are a deterrent to a high level regional facilities' approach. No less important, however, is a regulation of the Department of Health, Education and Welfare which states that applicants for demonstration project grants under the Solid Waste Disposal Act of 1965 must give assurance that open dumping and burning are not permitted within the area in which the grant is to be used. If such assurance is not provided, the applicant may instead submit a plan to be followed in eliminating open dumping and burning. Thus, as a means of obtaining funds for experimentation with new waste disposal methods and techniques, it is important that such legislation be passed.

SOLID WASTE DISPOSAL PROGRAM
for
METROPOLITAN BOSTON

VOLUME I

PART II

prepared by the
METROPOLITAN AREA PLANNING COUNCIL

CHAPTER 1

TYPES OF WASTE, DISPOSAL METHODS, AND TRANSPORTATION COSTS

In view of the preceding discussion of waste disposal problems, the purpose of this chapter is to:

1. Describe the various types and quantities of wastes produced in the Metropolitan Area.
2. Provide an analysis of the various methods of disposal available and their practicability for the Metropolitan Area.
3. Present a discussion of collection, transfer, and hauling practices and their feasibility in the Boston Metropolitan Area.
4. Relate collection and hauling costs to disposal costs and to the size of the operation contemplated.
5. Review current methods of controls and finances, as well as past proposals.
6. Summarize the current organization of waste disposal services in the region.

Sources, Types, and Composition of Wastes.--In almost any community, the volume, type, and composition of wastes collected will differ with the source of pick-up. Residences, industries, stores, schools, and hospitals produce a variety of waste materials (garbage, rubbish, chemical, pathological, etc.) which require the use of a variety of disposal methods. Thus, the refuse collection process must often distinguish between materials which will be picked up in the regular collection, and those which must be disposed of in a special manner. As a method of classification, wastes

are generally placed in the following categories: household rubbish, street wastes, commercial and industrial wastes, demoltion and construction materials, and the special wastes (pathological, chemical, explosives, and dead animals). Household wastes are estimated to be 60-65% of the total waste volume. Composition of household wastes in the metropolitan area was found to be predominately waste paper, cardboard, tin cans, some plastics, synthetic materials such as nylon, and garbage. The increasing emphasis and dependence upon prepackaged foods and the use of home garbage grinders have, however, produced a steady decline in the amount of garbage generated. In addition, as new materials such as plastics are produced and used, the composition of household wastes changes accordingly.

A second category of refuse--commercial and industrial wastes account for approximately 30 per cent of the total waste generated. This category, which contains large quantities of garbage, paper and cardboard, includes a higher percentage (25% of total) of non-combustible items, such as leather scraps and fleshings, rubber and metallic scraps, than do household wastes. While the volume of generation of these non-combustible items is not expected to change, an increase in paper, cardboard and plastic material is anticipated.

Still another class of waste includes the predominately non-combustible (up to 75%) demolition materials. This category includes all building and demolition rubble--brick, stone, lumber, etc. It was found that a major portion of this demolition material is generated by a relatively small section of the metropolitan area. This can be demonstrated by Census of Housing data in which it is found that based upon substandard housing estimates, it was found that 58 per cent of all substandard housing (which we assume will eventually be demolished) in the metropolitan area was attributed to Boston, 6 per cent to Somerville, 4 per cent to Lynn, 3 per cent to Cambridge, and 3 per cent to Salem. (The remaining 26 per cent is scattered throughout the metropolitan area.) It is obvious that demolition wastes will mainly be generated for some time to come in the older central cities.

Special wastes such as explosives, pathologic materials, and dangerous chemicals are included in yet another grouping. These wastes are attributed to a variety of sources--for example, hospitals, industries, and research centers may all be contributors. Since such materials normally require special handling, they were not considered in calculations of estimated disposal volumes.

Quantities of Refuse--Present and Projected.--While the capacity in existing disposal areas continues to decrease, the amount of waste being generated in the metropolitan area is

rapidly increasing. Based on the interviews and questionnaires, we have estimated the present production of waste at 2,668,000 tons. This figure includes 1,345,000 tons from residential and small business sources; 870,000 tons from manufacturing plants, warehouses, banks, office buildings, etc.; 409,000 tons of demolition materials; 67,000 tons of special collection items (junked appliances such as stoves, refrigerators; old sofas; t.v.'s, etc.) and 79,000 junked vehicles. By 1990, however, this volume is expected to nearly double, thus approaching 5,000,000 tons per year.

Household Waste.--At present, the Boston area per capita generation rate is an annual 850 pounds of rubbish and 150 pounds of garbage. Within the city of Boston, however, these volumes were found to be slightly lower--approximately 660 pounds of rubbish and 140 pounds of garbage. These lower figures may be partially attributed to the amount of refuse burned in apartment house incinerators and to the fact that some private contractors may be hauling refuse to points outside of Boston proper. With no reversal of the trend toward more packaging and throw away cartons in sight, this per capita figure is expected to increase at an annual growth rate of 2 per cent, thus accounting for the sharp rise in residential waste volumes. An analysis of the content of "ordinary refuse" would show the following:

Typical Refuse Composition (By Weight) *

1. Putrescibles such as garbage, swill, garden trash and grass----------5% to 15%.

2. Paper of all types, including various synthetic wrappings----------40% to 60%.

3. Rags, including synthetics----------1% to 3%.

4. Tin cans (tin content about 15 lbs. per ton of iron) ----------5% to 10%.

5. Metals, ferrous and non-ferrous----------1% to 3%.

6. Ashes and dirt----------3% to 20%.

7. Glass----------3% to 9%.

8. Miscellany (wood, plastics, synthetics)----------2% to 6%.

It was found that the density of loose household wastes is 250 lbs./cu. yd. for combustible materials and 300 lbs./cu. yd. for non-combustibles.

Bulky Household Wastes.--Special collection items, defined as bulky furniture, appliances, and other items which cannot fit into the regular collection system, were estimated for the entire metropolitan area and projected on the basis of a two-week sampling of bulky items in Boston, Newton, Watertown and Medford. The estimated total tonnage of this material is 44,000 tons.

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* Rogus, Casimir. "Refuse Collection and Disposal". Paper presented at the First New England Conference for "Urb .n Planning for Environmental Health", Tufts University, September 8 - 10, 1965.

Commercial and Industrial Waste.--Tonnages (1965) for industrial and commercial establishments were estimated from the results of a sampling of 400 firms in the Metropolitan Area. The usable returns indicated an average of 1.25 tons of solid waste per industrial employee and .5 tons per non-industrial employee per year. These usable returns represented 151 firms employing 27 per cent of the Metropolitan area's industrial employment. Thus, from this source, a total of 870,000 tons is estimated.

The Massachusetts Rubbish Haulers Association was also contacted, and they agreed to distribute a simple questionnaire to their members. Replies were received from 15 firms operating 128 trucks. The weekly volume of non-residential wastes collected by these 15 firms (excluding demolition material) was 4582 tons or about 238,300 tons per year. This amount probably represents about one-fourth of the total amount of non-residential wastes -- the total estimated thusly at 953,000 tons.* The density of these non-residential wastes is estimated to be approximately 300 lbs./cu. yd. for

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* A spokesman for the 56 member Rubbish Haulers Association estimated that members operate a total of 500 collection vehicles. Thus, our 15 replies represent about one-fourth of the number of refuse hauler firms and one-fourth of the total commercial hauler truck fleet and it is reasonable to assume, therefore, that they are collecting one-fourth of the total amount of non-residential solid waste.

combustible materials. (Because of the wide variability of non-combustible commercial and industrial wastes, the density for these non-burnables is difficult to pinpoint.) Although the total tonnage estimated in this manner is about 10 per cent higher than that estimated from our sample of individual commercial and industrial firms, the higher figure may be explained by the fact that the 15 rubbish haulers were large firms, and they probably collect somewhat more than one-fourth of the total amount of non-residential refuse.

Projected tonnages of industrial waste were based on the 1965 total, with allowances for employment growth. Because of industry's greater tendency to salvage and minimize waste, however, the generation rate per employee was assumed to remain constant. Industrial and commercial wastes are thus directly related to anticipated employment growth.

Special Wastes.--Still another type of wastes investigated were the special wastes. These, as earlier noted, include such materials as chemicals, radioactive substances, explosives, oil residues, etc. It was found that many such materials are highly combustible or otherwise hazardous and in most instances their disposal is supervised by designated technical agencies. Two additional special wastes--agricultural and fishing wastes--were also studied, but were found to

present no serious problems for the Boston metropolitan area. (The amounts of agricultural wastes are small, and often reused on farms, while fishing wastes are taken to fish rendering plants where they are used as a base for fertilizers, chicken feed, and dog and cat food). Thus, it was felt that these wastes were not significant in estimating disposal requirements.

Junk Autos.--Junk autos are a final type of waste materials which are a part of the disposal problem. As the number of car owners has increased, the number of cars destined for disposal has also increased. The volume of junk autos was estimated by using the vehicle stock figures calculated by the Council's Economic Base Study and the industry's quoted average vehicle life span of 10 years. By projecting the yearly ownership of automobiles to 1990, we found that by 1975, there will be an area-wide auto retirement of 100,000 and by 1990, 163,000.

The increasing amount of auto scrap which these figures indicate cannot, however, find total consumption in the scrap industry. The decreasing dependence of the steel industry on No. 2 scrap bundles (composed predominantly of auto junk scrap), and the related decrease in the price paid for such bundles, has been passed from the scrap processor to the

auto wrecker to the general public. Number 2 scrap bundles, composed mainly of auto scrap, contain a high level of impurities--both ferrous metals and dirt. Because of these impurities and the introduction of a new steel-making process, steel mills and foundries have experienced a reduced need for scrap metal of this caliber.

In addition, scrap metal is bought and not sold and the consuming industries set the price which they feel they can afford. A high demand and pressing need for scrap metal in 1956 pushed the price up to $42.86 per ton. In contrast, the low demand and slight need pushed the price to a 1963 low of $19.84 per ton.

One method of processing junked autos so that the resulting scrap product is of a high and usable quality, and at the same time allows a sufficient margin of profit, is the "Proler Method." This technique will be discussed in a later portion of this report.

It is anticipated that the new Proler plant in Everett will greatly reduce the number of junked cars which must be included in our volume estimates for needed land requirements. Letters received from various communities where Proler plants have been constructed indicate a significant drop in the number of junk vehicles requiring disposal. It was also noted that the effects were felt over a wide area--as much as 200 miles from the plant itself.

DISPOSAL METHODS.

Current Situation--Based upon existing information for 63 Metropolitan Area communities which use open dumps and sanitary landfills for waste disposal, it has been determined that only 5 of these communities have enough capacity in present facilities to handle anticipated waste volumes over the next 25 years. The remaining capacity in disposal facilities varies widely among communities ranging from zero to 2,300,000 cu. yds. Each person in our metropolitan area generates enough household waste to utilize 1.7 cu. yds. per capita of landfill (at 600 pounds per cu. yd.) per year. If, however, all solid wastes are included, this required area rises to 3.1 cu. yds. per capita. These calculations indicate that the greater portion of the metropolitan area dumps and landfills will be exhausted within 10 years.

In addition to the fact that the current capacities are sadly inadequate to handle future waste production increases, it is interesting to review the type and condition of presently operating facilities. Our 1965 survey, conducted by a sanitary engineer from the Massachusetts Department of Public Health, noted that in 64 of the 79 communities there were 76 open dumps, 15 incinerators, and 3 "sanitary landfills."*

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*These 3 landfill operations are the only facilities in the metropolitan area which meet the standard definition of a sanitary landfill--that is, a designated dumping area which is covered on all exposed sides and compacted daily. All burning is prohibited and required site improvements such as snow fences, water, supervising personnel, etc. are provided.

Fifteen communities had no facilities whatsoever. While the open dump is by far the most common type of facility and the least expensive to run (in terms of actual dollar cost), it is rapidly becoming recognized as a potential detriment to the health and welfare of any community. For example, in a majority of communities visited in our 1965 data survey, the visiting sanitarian noted numerous instances of open and uncontrolled burning, heavy smoke and odors, lack of adequate supervision and equipment, rodent infestation, and proximity to community water supplies and recreational areas. These nuisances were not only common at open dumps, but were reported at areas purported to be operated as sanitary landfills. Observations at such areas indicated a lack of adequate cover material and equipment, refuse which was not compacted and covered daily, poor supervision, noticeable odors, and burning. It would appear from such observations that most of the facilities which are presently tagged as sanitary landfills, should indeed be categorized as open dumps.

Open dumps and sanitary landfills were not, however, the only methods of disposal which were found to be inadequate. In many instances, poor operations or designs of incinerators were also cited. Reports and later observations noted stack emissions of heavy black smoke and fly ash, small capacities in burning and storage pits, incomplete combustion processes, and large discrepancies in design capacity versus rated capacity.

Later findings have indicated that in many cases the incinerator capacity has been overrated by as much as 40 per cent.

Regardless of the type of disposal method in use, observations throughout the metropolitan area have uncovered serious threats to the health and safety of the community's citizens. Keeping these nuisances and inadequate facilities in mind, it is important to discuss the various disposal methods available, and to note significant research efforts on methods for the future.

A. INCINERATION

Refuse Reduction--Incineration, an enclosed combustion process, is by far the most efficient method of refuse reduction for solid waste materials. It is generally agreed in technical reports that a breakdown of refuse by weight will show a range of 60 to 90 per cent for combustibles and 10 to 40 per cent for non-combustibles. Local public works and health officials questioned in 31 of our metropolitan area communities, estimated an average refuse composition of 85 per cent combustibles and 15 per cent non-combustibles. Any significant variation from these averages could most likely be attributed to the size of the community and to the differences in residential and commercial character of the community. In one regional study*, for example, the per cent of non-burnable materials ranged from a low of 8.6 to a high of 29.

An example of refuse reduction by incineration is found in records of test results obtained from a metropolitan area incinerator. The incinerator, consisting of two 50-ton batch-fed furnaces with rocking grates, was burning typical community rubbish containing little or no garbage. A total of 45.4 tons or 260 cu. yds. of refuse were burned in an 8-hour period. The estimated weight as delivered was about 350 pounds per cu. yd. The total amount of quenched ashes from one day of operation

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* Report of Regional Refuse Disposal for towns of Avon, Canton, Holbrook, Randolph and Stoughton.

amounted to 21.3 tons (30.5 cu. yds.) or 12 per cent of the original volume as handled. The average weight of quenched ashes was 1400 lbs. per cu. yd. While the weight of dry ashes was 1160 lbs. per cu. yd. If, then, the weight of the quenching water is omitted, 39 per cent of the original tonnage is residue. The organic material, unburned, in the residue was slightly less than 3 per cent.

If rubbish is compacted in a sanitary landfill to 700 lbs. per cu. yd., the reduction in volume would be 50 per cent. This compared to the above said figures for incineration demonstrates the 4 to 1 advantage in space conservation by incineration over sanitary landfill. Thus, while incineration must not be acclaimed as the "cure-all" to waste disposal problems, it can be accepted for its land-saving processes. If, for example, sanitary landfilling is the primary method of disposal used, an average of 15.5 acre feet per year per 5000 tons will be needed for waste disposal purposes. If, however, incineration is substituted as the method of disposal, only 3.9 acre feet of land would be needed for this same tonnage. If screened incinerator residue (ash free from cans, wire, etc.) can be used in fill and surfacing materials, it is possible that this land requirement could be reduced even further.

Types of Incineration. Incineration may be accomplished through any one of a number of processes. The two general types of incinerators are known as the batch-fed and continuous-

feed incinerators. Depending upon the kind of grate, however, there are a variety of continuous-feed furnaces which can be used. These include rotary kiln, traveling grate, rocking grate, and impulse grate.

In both the batch-fed and continuous-feed incinerator, the incoming refuse is dumped into storage bins, and transported from the pit to the furnaces by means of grab-bucket cranes. In a batch-fed furnace, the refuse is discharged intermittently (usually at 20-minute intervals) directly into the furnace. In a continuous-feed furnace, the refuse is discharged into a hopper and conducted through the furnace via traveling or hydraulically-actuated grates. The continuous-fed incinerator is preferred because of its ability to maintain a stable temperature and draft.

In any type of incinerator, however, provision must be made for the storage of rubbish and garbage, for ash residue and fly ash removal, and for the proper emission into the air of flue gases. Provision must also be made to maintain constant burning temperatures (above 1400^{o}) in order to prevent odors. Air pollution control regulations now being considered are much more stringent. It has become necessary to require the use of more complex and expensive pollution control devices as a means of restricting fly ash emissions. Although not new in design, electrostatic precipitators and glass bag filters are only presently coming into use to meet such requirements.

B. SANITARY LANDFILL.

Description--The term "sanitary landfill" is one of the most misused today, for in many instances, the words are used to describe what are blatant open dumping operations, rather than nuisance free, non-objectionable disposal methods. When properly operated, a sanitary landfill can be the least costly, least objectionable, and most positive approach to acceptable waste disposal (since the land can be reclaimed, shaped, and sculptured for future uses). On the other hand, a poorly operated or poorly-sited landfill may become as serious a health menace as an open dump.

In conducting a sanitary landfill operation, certain elements are essential to a proper operation. These include: daily compaction and covering of refuse, availability of equipment for maintaining the operation; the prohibition of all burning at the disposal area; provision for an on site water supply, fencing, housing for equipment, adequate cover material, access roads, and necessary drainage.

A typical landfill cell is usually 6-8 feet deep. Within a specified area, materials must be thoroughly compacted--usually with a bulldozer. Recommended sanitary engineering practice is that the working face of the fill be kept as narrow as is consistent with the proper operation of trucks and equipment, so that the area of exposed material will be at a minimum. All exposed faces of the fill must be covered daily with at least 6" of compacted cover material. The final compacted cover, when

a section is completed, should be a minimum thickness of 2', so as to provide an effective seal against underground fires as well as vermin and rats.

Sanitary landfills, however, may not be operated on just any piece of unoccupied land, for it has been well demonstrated that geologic conditions are a major factor in potential ground water contamination. Particular care must be taken, for example, in areas of high normal, or raised water tables during a rainy season, or where there are springs which can saturate the fill. Areas subject to flooding should be avoided unless protective measures are taken to prevent erosion or rinsing of the fill. The erection of protective dikes has been approved for such purposes by the Massachusetts Department of Public Health.

Swamplands are still another prohibited land area. In such areas, the rise and fall of impounded waters rinses the decaying matter and adds a heavy pollutional load to the surface waters. It is also recognized that filling of these lands may disturb the hydrologic balance by eliminating a portion of the flood plain and lead to greater runoff, flash flooding and erosion during rainy periods. While in many parts of the country, "low value" swamplands have been designated as prime filling areas, Massachusetts laws discourage similar operations through the so-called Wetlands Acts.* Thus, due to

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* Chapter 130 of the General Laws, as amended, by Chapter 426 of the Acts of 1963.
Chapter 131 of the General Laws, as amended, by Chapter 220 of the Acts of 1965.

both geologic environment and protective legislation, many acres of vacant land are virtually unavailable for sanitary landfill.

Sanitary landfills have certain general operational requirements. These will vary with the type and size of the operation and the conditions existing at the site designated. In general, one heavy tractor handling up to 200 tons/day is sufficient for all but the largest of landfills contemplated for the Metropolitan Area. Again, depending upon site conditions, other useful equipment might include: a tank truck with flushing hydrants, a scale for weighing entering refuse, and fencing to prevent blowing papers. In the more permanent operations, it may also be desirable to erect a shop and garage for storing and repairing equipment and for rest and warm-up of site personnel.

Manpower requirements would also vary similarly with the operation and site, but in general, for the smaller community landfills, a skilled equipment operator may be adequate for operation and supervision of the fill. Most landfills in this area could function well with one or two men, and a medium-sized operation (250 tons per day) could probably be carried out efficiently with six men. Regardless of the size of the landfill, however, a professional sanitary engineer should be available for at least periodic inspection and supervision of the operation.

In addition to the filling of large land area depressions, a landfill process may also be used for reclamation in harbor areas. Ash residue, for example, could provide a sufficient fill material, in a diked area, for such reclamation purposes. Pumping under the fill area (at any site where there is danger of water seepages), on a continuous basis, may be needed to prevent displacement of polluted waters.

One of the greatest advantages of a sanitary landfill is its ability to handle almost any type of waste produced. Not only combined quantities of garbage and rubbish may be disposed of in such a manner, but much of the non-combustible (junked appliances, demolition materials, etc.) and industrial wastes are also suitable for disposal therein. A second advantage of a landfill operation is its land reclamation properties. Abandoned sand and gravel pits and old quarry holes may, if properly filled, be converted into useful recreation areas. In some instances, such filled areas have even been used for industrial or residential development, although trouble has been experienced with methane gas generation. In areas where the required land acres are available, then, a <u>properly operated</u> sanitary landfill is recommended.

C. COMPOSTING

Description--Composting, while not used extensively in this country, is a third method of disposal to be considered. Composting may be described as a controlled bacteriological decomposition process. It is dependent upon proper control of moisture, temperature, nitrogen and oxygen variables. The resulting end product is a humus-like material which can be used as a soil conditioner. It has negligible fertilizer value. Various methods such as the "Naturizer", Dano, and Fairfield-Hardy systems are used to induce the decomposition process. No matter what method is used, however, it is necessary to sort the refuse, removing all non-compostables (glass, iron, non-ferrous metals, rubber-leather-plastic scraps, etc.). Such a procedure requires a combined hand and mechanical sorting process.

When compared with incineration, composting does not, however, fare well--for it is generally agreed that approximately 25 per cent of produced wastes cannot be composted, and that even after the remaining 75 per cent is composted, a volume of 50-60 per cent is left. If there is no market for the resulting compost product, this material must be rehandled and disposed of by an acceptable method, such as a sanitary landfill--thus adding to the cost of disposal. Although compost has negligible benefits when used as a fertilizer, it does have value as a soil conditioner as a means of reducing storm runoff. Even with such uses, however, the supply, at least in our metropolitan area, would

far outweigh the demand.

In many other parts of the country, composting has also been notably unsuccessful. While several plants have recently been constructed, in practically all instances operations have been shut down (plants in Phoenix, Arizona, and San Fernando, California, are prominent examples). Reasons given for these closures include operating costs far in excess of estimates and a lack of market for the end product. A large plant of about 120 ton/day capacity has been in intermittent operation at St. Petersburg, Florida, under contract with the City. It is reported that recent troubles with unpleasant odor emanation have caused some uncertainties as to the eventual satisfactory operation. Despite such failures, a great deal of optimism remains, and several compost plants are under construction. A joint venture (Tennessee Valley Authority and United States Public Health Service), for example, is now under construction in Johnson City, Tenn. When completed this year the facility will be equipped to handle approximately 60 tons/day. It is suggested that, until such operations have been proven successful, composting be rejected as a major disposal method for the Boston metropolitan area.

D. OPEN DUMPING

Although open dumping is the most predominant method of disposal in the metropolitan area, it is an unsanitary and outmoded process and should be abandoned as soon as possible. As the Massachusetts Department of Public Health has stated, even its least cost argument must be rejected, for ". . .consideration of cost usually does not include the cost to the local fire department for putting out fires, the cost of the water used by the dump personnel for the same purpose, and the cost of damage to tire, axles, and springs of collection vehicles and fire trucks, nor does it include the depreciation of real estate values in the vicinity of the dump or the value of the comfort and convenience of that part of the population affected by the objectionable conditions created. If these factors are considered, the total cost will approach that of more suitable means of disposal."*

*Massachusetts Department of Public Health, Refuse Disposal Method (1965), p.4.

E. HIGH-TEMPERATURE INCINERATION

Description--Still another method of disposal which merits discussion is a new process involving high temperature incineration. Utilizing a blast furnace method of incineration, this type of operation is able to produce temperatures in the vicinity of 3000°F.--thus reducing materials including metals, glass, and plastics, to a molten mass. This liquid mass is transformed, by water quenching, to small metal-like fragments. Commonly, only a 2 per cent residue (by volume) will remain as an end product. Temperatures are maintained at these high degrees by use of auxiliary fuels such as coke. Materials up to 6' in length may be dropped into the furnace opening. In light of pending air pollution standards, care must be taken to provide the equipment necessary for dealing with air pollution problems.

Although no such high-temperature incinerators are yet operating on a community basis, there is a pilot plant in the town of Whitman, Massachusetts. It is thought that of all the newly-developed methods for disposing of solid wastes, this one appears to have the greatest promise for future application of waste disposal problems.

F. SHREDDING, CRUSHING, and BALING

Although not widely used in the metropolitan area, another method of disposal is performed by shredding, crushing, and baling equipment. Much of this type of equipment is, however, designed with a specific purpose in mind. Thus, a car crushed or a baler probably will not be used for shredding of ordinary refuse. In addition, the costly nature of such equipment (an approximate range of $70,000-$950,000) would appear prohibitive, in all but the largest of areas, if more than one unit were required.

It cannot be denied, however, that shredding and baling equipment is one of the most efficient means of reducing bulky materials. For example, a whole car (minus the engine block and tires) can be crushed into a 2' square bale of metal in less than a minute. A shredding plant, owned and operated by the Proler Corporation, has recently been constructed in Everett. Corporation literature indicates that the plant can process up to 1400 junk autos per day, and can serve a market in a 250-350 mile radius. The approximate cost of such a unit is $2,000,000. Junk appliances, such as refrigerators and stoves, can also be handled in this manner.

A second example of this shredding-grinding process is found in Montreal, Canada. Here, two 200 ton per day grinders are being used on municipal refuse before depositing and compacting it in a sanitary landfilling operation. It is esti-

mated that this preprocessing of the refuse reduces the volume required for ultimate disposal by as much as 20 per cent.

Still another example of these methods is a new crushing and shredding plant in Tampa, Florida. A wide variety of materials are handled by this plant without difficulty. In a demonstration of the plant, demolition wastes from a 3-family dwelling, as well as refrigerators, stoves, automobile tires, automobile engines and frames, tree stumps, and a large electric utility pole were all ground up within a two-hour period. The equipment used consisted of a stationary mounted crane with grab bucket loading the bulky refuse into a conveyor; a large rotary crusher and shredder; separate conveyors for organic and metallic residue, a wet scrubber for cleaning dust-laden air from the process, and ballistic and metallic separators for classifying the scrap metals. The plant is operating every day for a large scrap metal dealer. The scrap steel is sold to a new steel plant located on the adjacent parcel.

As the above descriptions may indicate, when used in conjunction with incineration and landfilling, this process could result in a significant reduction of the land area required for refuse disposal.

G. INCINERATION-AT-SEA

Although still in the research stage, a future method of disposal which merits discussion is incineration-at-sea. While previously practiced in both Boston and New York, ocean dumping has been prohibited for a number of years. Proponents of its elimination noted that the unburned refuse was frequently found washed upon beaches and shore lines in the area. The new plan, however, calls for the conversion of old Liberty ships or barges to sea-going incineration plants. Refuse would be transported to shore side transfer stations, loaded aboard the converted ships, and taken to sea. Burning would take place off shore or possibly at dockside and the non-floatable ash residue would be dumped overboard.

At present, this method of disposal is being studied by the Harvard University School of Public Health. Obvious advantages of utilizing such a disposal process include the elimination of metropolitan air and water contamination contributed by waste disposal, and the practically inexhaustible potential of the holes in the ocean floor. In addition, most of the population of Greater Boston resides within 10 miles of the sea coast. There are, however, many variables which must be investigated. These include: the nature of the ash residue, tide and current conditions, effects of pollutants in air at sea, assessment of marine biological effects, and combustion studies. Cost studies based upon crew size, over-

time pay, and marine union requirements should also be undertaken.

Thus, while incineration at sea could provide a future solution to metropolitan disposal problems, there are many questions which must be answered before it can be approved as a possible area disposal method.

H. PYROLYSATION

The City of San Diego, California is investigating the feasibility of a new method for the disposal of municipal refuse. The method, known as pyrolysis, has been used at several sawmills for the destruction of sawdust and wood chips. Combustible gases and a form of charcoal were the residue. It has not been used on a commercial scale for the reduction of municipal refuse.

One maker of this process utilizes high-temperature pyrolysis in the absence of oxygen to convert cellulose and other organic matter to combustible gases (largely methane), to tarry liquids that are volatile at high temperatures but liquid at normal temperatures (known as "pyroligneous acids"), and to a charred high-carbon residue that can be made into briquettes for low-grade fuel. It is an old process that has been used for decades. It is closely related to the destructive distillation of wood to produce acetates and to destructive distillation of coal to produce coke and illuminating gas.

Pyrolysis undoubtedly has a good deal of potential for greatly reducing the volume of municipal refuse and for possibly yielding a char that can be used for fuel. It is expected that the combustible gases produced will be sufficient to provide the necessary heat.

A great deal of experimental work needs to be done before the feasibility of pyrolysis for disposal of municipal refuse

can be demonstrated, both as an acceptable and economic method. The aforementioned San Diego studies should help to determine this feasibility.

Until much more is known about pyrolysis of municipal refuse, it should be considered only as a possible future method.

COLLECTION, TRANSFER, HAUL

The collection, transfer, and haul phases of waste disposal account for between 50 and 75 per cent of the total disposal cost. Thus, it is of importance to discuss the various collection and transportation methods available, and to relate them to current metropolitan area practices.

Collection practices may greatly influence the operation of the disposal method used. If, for example, separate collections (garbage collected separately from rubbish) are preferred, it is very difficult to incinerate the garbage because of its wetness. If, however, the putrescible material is mixed with ordinary refuse, the combustible nature of the mixture is enhanced. The process of mixing the refuse at the incinerator is much more costly in terms of labor than if a combined collection system were instituted at the source of pick-up. Materials received from combined collections are also suited for disposal in a sanitary landfill. Here again, the mixed refuse can be easily disposed of through cover and compaction. However, for a third method of disposal, composting, either method of collection (separate or combined) has its problems because the process usually involves mixing organic rubbish with garbage, and the separation of non-compostable objects (pieces of inorganic material such as glass, plastics, metals, etc.). Putrescible materials which have not, however, been combined with other

types of waste products, must, in most instances, be collected and then transported to rural area piggeries, which generally amounts to a duplication of the collection process and a costly long distance haul.

In our survey of communities in the metropolitan area, we found that the majority of cities and towns have separate collection of both garbage and rubbish. In 67 of these communities, garbage is taken to piggeries, while in only 12, garbage is combined with rubbish in the final disposal process. This combined disposal is generally permitted in the few cities and towns where individuals are making their own arrangements for both garbage and rubbish disposal, or, as in Marblehead where garbage and rubbish are combined for disposal in the incinerator.

Household Collection--The collection practices common to our metropolitan area are not widely used throughout the rest of the country. As earlier noted, the collection system in the Greater Boston area has almost 100 per cent separate collections. The garbage collected separately is transported to piggeries (it may also be burned) where it is used for feeding swine. In most areas of the country, however, combined collections are almost universally employed. One of the most persuasive reasons for recommending combined collection is its substantial savings over separate collection. In one metropolitan area community, for example, a news

article noted that if a combined collection was instituted, the total collection cost would be reduced from $391,000 to approximately $290,000.* As the metropolitan area continues its development trends, piggeries are forced to move further from the population centers--and garbage collections continue to become more costly. It is recommended that the metropolitan area communities institute combined collection services.

In addition to the problem of separate vs. combined collections, there is the question of point of pick-up. While refuse is most often collected from curbside, it may also be collected from the cellar or back yard. Covered metal or plastic 30-gallon containers are usually cited in bylaws and ordinances as permissible containers. In our metropolitan area, it was found that rubbish is generally collected from non-standard containers placed at curbside. In the Back Bay area of Boston, however, these collections are made from the alleys. Packer trucks of 16 and 20 cu. yds. (some 25 cu. yd. trucks are also used) are used for collection services. These trucks compact the rubbish from a density of about 250 pounds per cu. yd. to about 550 pounds per cu. yd. Garbage, on the other hand, is usually removed from underground receptacles in back yards. Specially-designed packer trucks--usually not exceeding 12 cu. yds.

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*Quincy, 1963.

capacity--are most often used for these collections. Disadvantages of such back-yard pick-ups are the liabilities that municipal employees may incur when entering upon private property for the collection of refuse. These liabilities, however, are removed in curbside and alley pick-ups. It is recommended that these curbside collections be continued with a single combined collection of rubbish and garbage at intervals not exceeding once a week in winter and twice a week in summer.

Commercial and Industrial--While in most instances the municipalities consider themselves under no obligation to collect from commercial and industrial establishments, it was found that many communities provide service to the small downtown business establishment. If such service is not provided, however, this commercial and industrial refuse is most often collected by private contract (contracts between the proprietor and disposal company). Equipment used for commercial collections often consists of 10-12 or 20 cu. yd. heavy duty, self-covered steel rubbish containers. These containers are picked up by the hauler by means of a special fork-lift tractor truck. The material collected usually arrives at the same point of disposal as ordinary household refuse--the open dump. The methods of collection for industrial and commercial wastes are generally in line with those in other parts of the country. This consistency

is attributed to the competition requiring high efficiency in management.

Other Types of Collection

1. Apartment Houses--As a means of minimizing fire hazards and needed storage area, many multi-dwelling unit buildings have installed apartment house incinerators. In a simple flue-fed incinerator, the householder discharges rubbish into a centrally-located chute (usually at the end of each corridor). The refuse is dropped through the chute into the incinerator furnace. Most of these incinerators are equipped with automatic-lock doors--thus, preventing the chute door from opening if the incinerator is burning. In a double flue incinerator, one flue is used for charging and the other for removal of gases. Oftentimes flue fires result (particularly in the one flue furnaces) when rubbish in the chute is ignited by escaping hot gases. Such incinerators are not recommended because of their generally poor quality of combustion, odors, and lack of adequate air pollution control equipment. In addition, new air pollution codes (for example, the codes effective in New York City) are discouraging the use of such incinerators--thus returning the burden of refuse collection to the establishment owner. One particularly promising new development involves a specially-designed paper bag and compaction unit. The standard refuse chute discharges refuse into the compaction unit which, in turn, compacts the

refuse into a super-strength bag. When the bag is full, the compactor automatically releases the full unit and replaces it with a new bag. In a similar manner, these compactors are being used in the handling of hospital wastes (here, super-strength plastic bags are used). The compacted bags may then be picked up, using the regular collection processes.

2. Special Collections--Open trucks, although not used in the collection of rubbish and garbage, are currently used for the removal of special collection items. The collections, usually in the form of Spring or Fall clean-up weeks, are provided for the pick-up of junk appliances and furniture. These items generally arrive at the same point of disposal as the householder's rubbish--the open dump. Newspapers, another special collection item, are generally sold as salvage material.

3. Leaf and Catch Basin Collections--Both leaves and catch basin wastes are collected by various methods. In some communities, for example, leaves are picked up by the same packer trucks which collect the rubbish. In others, however, the leaves are collected and compacted by vacuum trucks. Catch basin wastes (leaves, paper, sand, grit, etc.) are removed by grab buckets or eductors.

TRANSPORTATION

A very important aspect of any solid waste disposal program is transportation, and in any regional arrangement the transportation system becomes most critical. All types of waste have something in common in that they must be transported from point of origin to point of disposal. This process may involve a very sophisticated system or a very simple one. A community may, depending upon financial resources, technical ability, and sheer preference, employ any one of a number of hauling vehicles which may or may not be the vehicle in which the refuse was originally collected. Many communities are now experimenting with the use of either one or a combination of: standard packer trucks; tandem trailer vehicles; containerized fork-lift systems, railways, barges, and even helicopters. In the following discussion, these various systems are explained.

Trucks--Communities which are fortunate enough to have adequate and accessible land within economical haul distance often employ a system which features standard packer trucks. The raw refuse is received, compacted, hauled, and dumped by a single unit.

To accommodate such a system, selection from a wide variety of vehicles is available. Compaction ability is measured in pounds per cubic yard. The refuse as received has a density of about 250 pounds per cu. yd. Many of the new compactors will double this density to 500 pounds per cu. yd.

Vehicles are often listed as 12, 16, 20, 25, 30 and 50 cubic yard haulers.

Buyers can also obtain vehicles which load from the front and which are sometimes more adaptable for industrial and commercial pick-ups. These compactors transfer wastes from individual on-site waste containers by means of hydraulic fork lifts which hoist the containers over the cab and into the packer body.

Such units are also being used in the rehandling of refuse collected in "back-yard" pick-ups. To facilitate these back-yard collections, communities are presently experimenting with container train systems. Flexibility and maneuverability can be achieved by using a low horsepower vehicle, such as a tractor, to haul a series of small yardage (usually 2 to 6 yds.) hand-loaded containers. The containers are designed and balanced so that they can easily be handled by a one-man operation. Once filled and hauled to a transfer vehicle, these containers can be unloaded by a front-end loader. One transfer truck can accommodate several such trains before heading for the disposal site.

In some parts of the country, notably Los Angeles County and Detroit, Michigan, communities faced with a shortage of dumping area and the prospects of long-distance hauling, are experimenting with transfer stations and trailer compactor systems. The point at which a community decides to replace

direct hauling with transfer equipment is often disputed, but serious consideration should be given when haul time exceeds 45 minutes per round trip. Trailer units may be used as both ground pick-up and transfer units. Lack of maneuverability makes them more desirable as transfer units, as devices for furthering compression, and for reducing trips to the final disposal site. Trailer capacities range from 32 cu. yds. to 60 cu. yds., and most of them are capable of compacting refuse to as much as 800 pounds per cu. yd.

Barge--A method which has been used in several coastal cities, and which is currently under study at Harvard University's School of Public Health, is the transporting of wastes by barging and shipping. In New York City, for example, refuse is barged from Manhattan transfer stations to Staten Island landfill operations where it is used as a fill for low land areas.

In the Boston metropolitan area, however, such barging operations have included the practice of burning the refuse at sea. An example of this type of operation is the Boston Marine Disposal Corp. Waste materials, composed predominantly of demolition lumber, are loaded aboard barges having a capacity of 1800 tons. Burning aboard the barge takes place at a point not far from Boston Harbor Light. Taking approximately two days to burn and three days to cool, the residue is then brought back to dockside where it is sold for fill

material.

Barging as a method of hauling and disposal should be further investigated. In Massachusetts, however, legislation discourages the filling of marshlands--thus limiting the initiation of a plan similar to the operation carried on in New York. It is suggested that the Harvard study of incineration-at-sea could successfully combine the transportation method of barging with the disposal method of incineration. Results of this study should be examined before a more definitive conclusion is reached.

Air--Still another alternative, although certainly less practical than any of the above-discussed methods, is that of transporting wastes by air. The State of Hawaii is currently experimenting with a method of pick-up and disposal by helicopters. Now practiced only in remote sections of state recreation areas, it is thought that such a method would be impractical and prohibitive in cost for a densely-populated area.

As we progress in space and aviation capacity, speed and flexibility, other methods of transportation and disposal of solid wastes could be developed.

Rail--Still another possible transportation method is hauling by rail.

One of the newest ideas would utilize portions of the metropolitan railroad system for transporting refuse.

In discussions with the New York Central Railroad, it was learned that a rail disposal operation has been under study for the past two years and that preliminary proposals have been made for several communities. The proposal includes rail hauling of wastes from a designated transfer station on the line to a relatively distant sanitary landfill also on the line. Initial costs (including cost at origin) have been estimated at $4.50-$5.00 per ton. Haul distances could run as high as 150 miles. It is hoped that as a means of waste control, the community (or communities) involved would own the origin or transfer station. It was also emphasized that while the landfill would be a contract operation not owned by the railroad, the railroad would assume responsibility for disposal of the refuse, upon delivery to railside collection stations.

Although not yet widespread in operation, transportation of refuse by rail is certainly a proposal worthy of further consideration. In areas hampered by dense population and little vacant land, the search for new techniques and disposal areas continues. A method of long-haul, low-cost transportation could produce a long-term solution to such urban waste problems.

Underground Piping--An apartment house complex in Sweden has resorted to use of a 24-inch underground piping system for transportation of refuse. A vacuum is maintained in the line

and the refuse from individual apartment chutes is admitted by valving and conveyed to a central incinerator. The system, although very costly, is now under consideration for a similar apartment house development in England.

EXISTING LEGISLATION FOR SOLID WASTE DISPOSAL

It is important to review the controls which govern refuse practices, and the efforts which have been made to promote the regional organization of solid waste disposal facilities.

Cities and towns in the Commonwealth of Massachusetts have traditionally conducted waste disposal operations on an individual community basis. The General Laws as originally enacted, delegated the general supervision of these procedures to the local boards of health. Individual communities continue to act independently despite recent amendments to the General Laws which were designed to encourage intermunicipal and regional organization.

Chapter 111 in Sections 143 and 122 instruct local boards of health to abate both noise and nuisances which result from waste disposal activities. Sections 31 A and 31 B of the same chapter enable cities and towns to initiate and enforce rules and regulations for collection and disposal operations by private companies.

A common municipal procedure is to contract with private companies for the performance of certain municipal services. The power to contract for solid waste disposal and removal services in the Commonwealth of Massachusetts is set forth in Chapter 40 of the General Laws. Section 5 has been amended

to allow all municipalities to make twenty year maximum contracts with private companies for the disposal of waste by any approved method.

In addition, at least one municipality (Quincy) has been given the power to contract for both the construction and operation of a facility for incineration, compost, or land fill for the disposal of waste.

If municipalities choose to conduct their own waste disposal programs, the General Laws make the following provisions. Municipal departments of health are allowed to appropriate funds and incur indebtedness for the construction and maintenance of incinerators for garbage and waste disposal. Appropriations for incinerator construction are generally within the debt limit, although the limit may be exceeded with the approval of the Emergency Finance Board.

On the surface it would appear that existing statutes adequately provide for community waste disposal needs. However, as has been noted, a close examination of the metropolitan situation indicates that many municipal operations would not be acceptable, if health standards were adopted and enforced. The changing nature of the waste problem has not been met by the implementation of corresponding changes in administrative procedure. Municipal inability to give waste disposal a high budgetary priority as well as changes in the composition of products to

be disposed have intensified the disposal problem.

Even for the individual, solid waste disposal is an area-wide problem. Smoke, dust, dirt and noise know no political boundaries. Smoke from a burning dump in one community may affect the citizens in an adjoining community. Water resources for some communities have become dumping grounds for others.

It is with these considerations in mind that an attempt to develop a regional solid waste disposal program for the metropolitan area was made over 15 years ago. In 1951, the state legislature by Chapter 22 of the resolves directed the Metropolitan District Commission (MDC) conduct a study to determine the feasibility of establishing a system of regional incinerators. The MDC conducted its study with the assistance of a consulting engineering firm. The study report submitted to the legislature as House No. 2360 of 1952, proposed that the Commonwealth expend seven million dollars to build five regional incinerators in the metropolitan area. The report also recommended that the MDC be authorized to acquire the necessary land by eminent domain, float serial bonds, and allocate the costs equitably among the member communities.

The report was implemented by Chapter 559 of the Acts of 1952, and the potential regional incinerators were assigned to the following locations:

Southampton Street, Boston
Grove Street, Watertown
Mystic Valley Pkwy, Medford
Waste Lands, Revere
Granite Avenue, Milton

Several events occurred between 1952 and 1959, which prevented this regional plan from developing. The most important event was the enactment of a local option clause which allowed the governing bodies of the communities involved to approve the construction sites. This event, plus the enactment of several pieces of special legislation, reduced the number of potential sites from five to one. The Boston site was the only site to be developed (1959), and this as a city-owned and operated facility.

Two other attempts to regionalize were made by cities and towns outside of the MDC study area. By separate acts in 1958 and 1961 two intermunicipal incinerator authorities were established, the South Shore Incinerator Authority in 1958 and the Lawrence - Methuen Incinerator Authority in 1961. Both authorities were granted the power of eminent domain and the power to assess members for construction and operating expenses. Like the MDC study proposals neither of the two authorities has come into operating existence.

A fourth attempt at regionalism was made in 1965. Chapter 748, as enacted, extends to all communities in the Commonwealth the authority to establish regional refuse disposal districts. In contrast to earlier legislation which applied only to

incineration, this Act provides for disposal by sanitary land-filling, composting and other acceptable methods as well as incineration. No communities have yet taken advantage of this legislation.

Although legislation enabling regionalism on a voluntary basis has existed in the past and exists today, no regional system has been formed in the metropolitan area.

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